Energy Research Abstracts

Vol. 9, No. 3
February 15, 1984

Abstracts 4278-5662

Technical Information Center
UNITED STATES DEPARTMENT OF ENERGY

CURRENT AWARENESS PUBLICATIONS ON ENERGY

To provide complete coverage of literature related to major Department programs, announcement publications that are comprehensive in their coverage of certain energy fields are issued regularly. All information in these publications, plus additional backup information, is included in the Energy Data Base of the Technical Information Center; all references are also available for machine searching via the on-line retrieval system, DOE/RECON, and the commercial on-line retrieval systems. Descriptions of these current awareness publications, which are supported either directly or indirectly by the DOE, appear below. Department of Energy components may receive the listed publications free from the Technical Information Center, P. O. Box 62, Oak Ridge, TN 37831. Telephone (615) 576-1303; FTS 626-1303.

PUBLICATIONS OF THE TECHNICAL INFORMATION CENTER

Energy Abstracts for Policy Analysis (EAPA)

A monthly abstract journal devoted to the analysis of energy research, conservation, and policy. Scope and coverage are limited to substantive articles or reports and emphasize the following programmatic efforts; legislative, regulatory, and other legal aspects, social, economic, and environmental impacts; regional and sectoral analyses; institutional factors, etc. *EAPA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; domestic subscribers $6.00, foreign $7.50 per copy; annual cumulative index, domestic $10.00, foreign $12.50 per copy. The annual subscription price is $70.00 for domestic subscribers and $87.50 for foreign subscribers.

Energy Research Abstracts (ERA)

A comprehensive semimonthly abstract journal devoted to all areas of energy-related information produced by the Department of Energy, other U. S. government organizations, and foreign governments. *ERA* is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $165.00 for domestic subscribers and $206.25 for foreign subscribers. A single issue costs $9.50 (domestic) or $11.90 (foreign).

DOE Patents Available for Licensing (PAL)

DOE is prepared to grant exclusive or nonexclusive, revocable licenses under DOE-owned U. S. patents and patent applications; this semiannual publication provides abstracting and indexing coverage of this literature. *PAL* is available on subscription as PB84-946800 from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. The annual subscription price is $14.00 for domestic subscribers and $28.00 for subscribers outside the North American continent; prices for single issues are $7.00 and $14.00, respectively.

The following monthly update journals are available to the public on subscription from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161; use the identifying order number (PB- No.) when subscribing. The annual subscription rate for one volume (calendar) year (12 issues plus cumulative index) is $75.00 for domestic (North America) and $150.00 for foreign (outside North America) subscribers. A single issue is $7.00 (domestic) and $14.00 (foreign).

***Current Energy Patents (CEP)*–PB84-902800**

Provides coverage of the international patent literature, including patent applications, that concerns any aspect of energy production, conservation, and utilization.

***Energy and the Environment (EAE)*–PB84-914900**

Devoted to information on the impacts of energy-related activities and radioactive and nonradioactive pollutants on the environment.

***Fossil Energy Update (FEU)*–PB84-914600**

Devoted to information on the exploration, development, processing, and use of fossil fuels.

***Fusion Energy Update (CFU)*–PB84-915300**

Devoted to information on controlled thermonuclear fusion, including plasma and fuel research and power plant engineering and conceptual design studies.

***Solar Energy Update (SEU)*–PB84-914500**

Devoted to information on the utilization of solar energy, including biomass and tidal and wind power.

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Covers all aspects of acid precipitation, including effects and possible control measures.

***Coal-Based Synfuels (CBS)*–PB84-901400**

Covers all aspects of conversion of coal into gaseous or liquid fuels.

***Coal Preparation and Pollution Control (CPC)*–PB84-900800**

Covers all aspects of coal preparation and cleaning and reducing pollution from its direct combustion.

***Direct Energy Conversion (DEC)*–PB84-946600**

Covers the following areas: photovoltaics, magnetohydrodynamics, electrohydrodynamics, thermoelectrics, thermionics, and fuel cells.

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Devoted to information on the exploration, development, and utilization of geothermal resources.

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Covers all aspects of laser research and development, but excludes applications.

***Nuclear Fuel Cycle (NFC)*–PB84-913400**

Covers all aspects of the nuclear fuel cycle, both front end and back end.

***Nuclear Reactor Safety (NRS)*–PB84-913500**

Covers the following safety aspects: accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures.

***Radioactive Waste Management (RWM)*–PB84-902900**

Covers the following management aspects: transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers.

***Solar Thermal Energy Technology (STT)*–PB84-901200**

Covers research in materials, concentrators/receivers, salinity gradients, etc., for development of efficient and reliable solar thermal conversion systems.

***Unconventional Petroleum (UCP)*–PB84-901300**

Covers all aspects of secondary and tertiary recovery of petroleum and of oil shales and tar sands.

INTERNATIONAL ENERGY PUBLICATIONS

The Technical Information Center cooperates with the following organizations in the publication of international abstract journals: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts;* and (3) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts.* In each case, the cognizant foreign agency provides the non-U.S. information to TIC for inclusion in the Energy Data Base; in turn, TIC provides the U.S. information for input into the respective journal.

Atomindex

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from UNIPUB, 345 Park Avenue South, New York, NY 10010. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $290.

Biomass Abstracts

A bimonthly abstract journal with comprehensive coverage of information in any step involved in the eventual conversion of biomass to energy. *Biomass Abstracts* is available free to Department of Energy components and contractors from the Technical Information Center. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 42 IR pounds per year. Make checks payable to the Institute.

Coal Abstracts

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to Department of Energy components and contractors from the Technical Information Center. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 100 pounds sterling per year.

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ENERGY RESEARCH ABSTRACTS

ABOUT THE TECHNICAL INFORMATION CENTER

The Technical Information Center in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, the Center places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Whereas the literature of science is emphasized, coverage is extended to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish this mission, the Center builds and maintains computerized energy-information data bases and disseminates this information via computerized retrieval systems and announcement publications such as abstracting journals, bibliographies, and update journals. Direct access to the Center's most comprehensive data base, the Energy Data Base, is available to the public through commercial on-line bibliographic retrieval systems. The Energy Data Base and many of the Center's energy-related data bases are available to DOE offices and contractors and to other government agencies via DOE/RECON, the Department's on-line information retrieval system. The Center has developed and maintains systems to record and communicate energy-related research-in-progress information, to maintain a register of DOE public communications publications, to track research report deliverables from DOE contractors, and to test and make available DOE-funded computer software programs with scientific and management applications. The Center also maintains a full-scale publishing capability to serve special publication needs of the Department. To effectively manage DOE's technical information resources, the Center's program is one of continual development and evaluation of new information products, systems, and technologies.

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ABOUT *ENERGY RESEARCH ABSTRACTS*

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

ERA is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

ERA is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37831.

ERA is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $165.00 for domestic subscribers and $206.25 for foreign subscribers. A single issue costs $9.50 (domestic) or $11.90 (foreign). The cumulative indexes will be available in printed form from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, and in microfiche form from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161, and from Engineered Systems, P. O. Box 866, Oak Ridge, Tennessee 37831.

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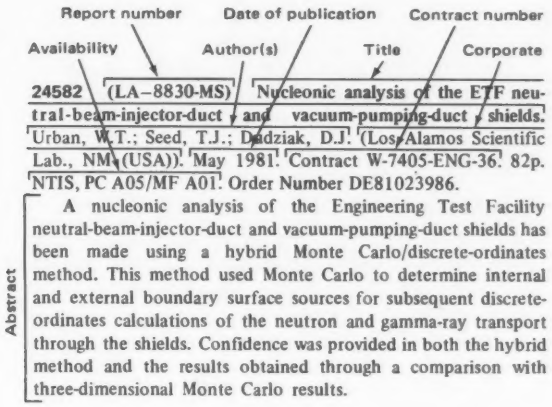
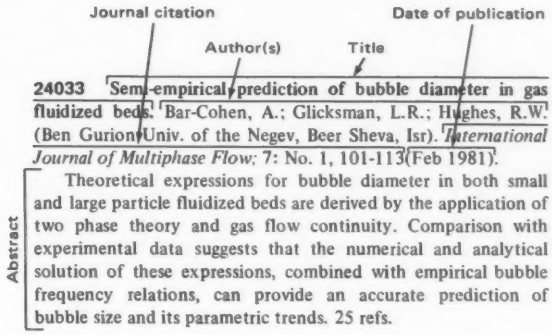
HOW TO USE *ENERGY RESEARCH ABSTRACTS*

ABSTRACTS IN *ENERGY RESEARCH ABSTRACTS*

The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.


Report number
Date of publication
Contract number
Availability
Author(s)
Title
Corporate
24582 (LA–8830-MS) Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields. Urban, W.T.; Seed, T.J.; Dudziak, D.J. (Los Alamos Scientific Lab., NM (USA)). May 1981. Contract W-7405-ENG-36. 82p. NTIS, PC A05/MF A01. Order Number DE81023986.
Abstract
A nucleonic analysis of the Engineering Test Facility neutral-beam-injector-duct and vacuum-pumping-duct shields has been made using a hybrid Monte Carlo/discrete-ordinates method. This method used Monte Carlo to determine internal and external boundary surface sources for subsequent discrete-ordinates calculations of the neutron and gamma-ray transport through the shields. Confidence was provided in both the hybrid method and the results obtained through a comparison with three-dimensional Monte Carlo results.


Journal citation
Date of publication
Author(s)
Title
24033 Semi-empirical prediction of bubble diameter in gas fluidized beds. Bar-Cohen, A.; Glicksman, L.R.; Hughes, R.W. (Ben Gurion Univ. of the Negev, Beer Sheva, Isr). International Journal of Multiphase Flow; 7: No. 1, 101-113 (Feb 1981).
Abstract
Theoretical expressions for bubble diameter in both small and large particle fluidized beds are derived by the application of two phase theory and gas flow continuity. Comparison with experimental data suggests that the numerical and analytical solution of these expressions, combined with empirical bubble frequency relations, can provide an accurate prediction of bubble size and its parametric trends. 25 refs.

INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

• Corporate Author Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

24582 (LA–8830-MS) Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields. Urban, W.T.; Seed, T.J.; Dudziak, D.J. (Los Alamos Scientific Lab., NM (USA)). May 1981. Contract W-7405-ENG-36. 82p. NTIS, PC A05/MF A01. Order Number DE81023986.

is indexed as:

Los Alamos Scientific Lab., NM (USA)
Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields, 6:24582 (R:US)

• Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Bar-Cohen, A., Semi-empirical prediction of bubble diameter in gas fluidized beds, 7:24033 (J:US)
Dudziak, D.J., *See* Urban, W.T., 6:24582
Glicksman, L.R., *See* Bar-Cohen, A., 7:24033
Hughes, R.W., *See* Bar-Cohen, A., 7:24033
Seed, T.J., *See* Urban, W.T., 6:24582
Urban, W.T., Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields, 6:24582 (R:US)

• Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

TOKAMAK ETF
Neutral Atom Beam Injection
Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields, 6:24582 (R:US)
Neutron Transport
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• Contract Number Index

DOE technical literature is indexed using contract numbers under which the literature was produced. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36 Los Alamos National Lab., NM (USA)
6:24582 LA–8830-MS

• Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under an Order Number, that number is included in the availability statement. An Order Number–Report Number Correlation is included for convenience.

LA–
8830-MS 6:24582 NTIS, PC A05/MF A01. Order Number DE81023986, Distribution Category STD-20d

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SUBJECT CONTENTS (NUMERICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 40 first-level and 293 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope definitions and limitations is available as DOE/TIC-4584-R5 from NTIS for $9.50.

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ENERGY RESEARCH ABSTRACTS

01 COAL AND COAL PRODUCTS

4278 **(ICTIS-RES—03) Coal research projects - Western Pacific, India and South Africa.** (International Energy Agency Coal Research, London (UK)). Jun 1983. 116p. IEA Coal Research, London, England.

A compilation of 826 research projects in progress or completed in the 4 years up to 1983, on all aspects of coal science and technology in the Western Pacific region, India and South Africa. The subjects covered are: general aspects of the coal industry (energy policy, marketing and economics, regulations), coal reserves and exploration, mining, preparation, transport and handling, processing and conversion, combustion and power generation, waste management, environmental aspects, coke and other products, health and safety. (36 refs.)

0104 Processing

REFER ALSO TO CITATION(S) 4319, 4334, 4345, 4355, 4356, 4418, 5080

4279 **(CONF-831063—10) Corrosion of alloys in direct coal liquefaction systems.** Keiser, J.R.; Olsen, A.R.; Judkins, R.R. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01. Order Number DE84003398.

From American Institute of Chemical Engineers fall annual meeting; Washington, DC, USA (30 Oct 1983).

The corrosion response of alloys in various process environments in coal liquefaction pilot plants is discussed. Causes of corrosion and limiting conditions (such as temperature, pressure, and fluid velocity) are addressed. Solutions and needed development are emphasized. Several direct coal liquefaction processes have been demonstrated on the pilot plant level in the United States during the past four years. Generally, petrochemical plant experience was used to select materials for these coal liquefaction plants, but several unanticipated corrosion and erosion problems were encountered. These problems are related to the presence of mineral matter and the relatively high sulfur, nitrogen, and chlorine contents of coal compared with petrochemical materials. These differences and their potential effects on materials degradation were recognized and discussed by earlier reviewers. The objectives of this paper are to list the potential causes of corrosion and erosion in liquefaction plants, to describe the materials requirements by functional area, and to relate the experience gained during operation of the pilot plants. In this paper, only those functions specifically involved in the coal liquefaction process itself are addressed.

4280 **(DOE/ET/10069—T44) EDS coal liquefaction process development: Phase V. Annual technical progress report, July 1, 1982-June 30, 1983.** (Exxon Research and Engineering Co., Florham Park, NJ (USA)). Sep 1983. Contract FC05-77ET10069. 156p. (FE—2893-116). NTIS (US Sales Only), PC A04/MF A01. Order Number DE84002941.

This report is the sixth Annual Technical Progress Report for US Department of Energy Cooperative Agreement No. DE-FC05-77ET10069 for EDS Coal Liquefaction Process Development Phase V. This report covers the period July 1, 1982 through June 30, 1983. Funding is shared by US Department of Energy, Exxon Company, USA (a division of Exxon Corporation), Electric Power Research Institute, Japan Coal Liquefaction Development Company, Phillips Coal Company, Anaconda Minerals Company, Ruhrkohle AG, and ENI. The agreement covers the period January 1, 1977 through December 31, 1985. The Laboratory Process Research and Development studies were conducted at various Exxon Research and Engineering Co. (ER and E) facilities: Research and Development Division at Baytown, Texas; Products Research Division at Linden, New Jersey; and the Exxon Research and Development Laboratories at Baton Rouge, Louisiana. The Engineering Research and Development studies were performed at the Synthetic Fuels Engineering and Exxon Engineering Technology Departments of ER and E at Florham Park, New Jersey. The information dealing with operation of the 250 T/D Exxon Coal Liquefaction Pilot Plant (ECLP) was generated at Exxon Company, USA, Houston, Texas.

4281 **(DOE/ET/13005—T12) Exxon Catalytic Coal-Gasification-Process Development Program. Final project report.** (Exxon Research and Engineering Co., Baytown, TX (USA)). Nov 1981. Contract AC01-78ET13005. 654p. (FE—2777-31). NTIS, PC A99/MF A01. Order Number DE84003530.

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The Exxon Catalytic Coal Gasification (CCG) Development Program began in July 1978 and was completed in March of 1981. The program was a coordinated effort involving bench scale R and D, operation of a one ton-per-day Process Development Unit (PDU), and engineering support. The PDU was being operated with bituminous Illinois No. 6 coal catalyzed with potassium hydroxide. This work was aimed at advancing the catalytic coal gasification technology through the development stage to make it ready for further scaleup in a large pilot plant. This report covers the activities for the Exxon Catalytic Coal Gasificaton Development Program during the perod July 1978 through March 1981. This work was performed by the Exxon Research and Engineering Company (ER and E) and was supported by the United States Department of Energy and by the Gas Research Institute. Contents of this report include: (1) bench scale research and development, (2) process development unit operations; (3) data acquisition and correlations; (4) advanced study of the Exxon catalytic coal gasification process; (5) engineering research and development; (6) appendix PDU yield period data.

4282 **(DOE/ET/14700—16) Chemistry and catalysis of coal liquefaction: catalytic and thermal upgrading of coal liquid and hydrogenation of CO to produce fuels. Quarterly progress report, July-September 1983.** Wiser, W.H. (Utah Univ., Salt Lake City (USA). Dept. of Mining and Fuels Engineering). Oct 1983. Contract AC22-79ET14700. 54p. NTIS, PC A04/MF A01. Order Number DE84002158.

Among the highlights to date is the fact that interaction effects between model reactions of binary mixtures representative of HDS, HDO, HDN and hydrogenation, using a sulfided CoMo/Al_2O_3 catalyst, were found to decrease individual reactivities in the order: N-compound > S-compound > O-compound > aromatic hydrocarbon. These results show that separate model compound reaction studies are insufficient to properly evaluate the various catalytic functionalities present on different sulfided catalysts. Other tasks are discussed in some detail also.

4283 **(DOE/FE—0028) Converting coal to liquid fuels.** (USDOE Assistant Secretary for Fossil Energy, Washington, DC). Jul 1983. 11p. NTIS, PC A02/MF A01. Order Number DE84003987.

Liquid fuels play a vital role in the US economy. Oil represents about 40 percent of the energy consumed each year in this country. In many cases, it fills needs for which other energy forms cannot substitute efficiently or economically - in transportation, for example. Despite a current world-wide surplus of oil, conventional petroleum is a depletable resource. It inevitably will become harder and more expensive to extract. Already in the US, most of the

cheap, easily reached oil has been found and extracted. Even under optimistic projections of new discoveries, domestic oil production, particularly in the lower 48 states, will most likely continue to drop. A future alternative to conventional petroleum could be liquid fuels made from coal. The technique is called coal liquefaction. From 1 to 3 barrels of oil can be made from each ton of coal. The basic technology is known; the major obstacles in the US have been the high costs of the synthetic oil and the risks of building large, multi-billion dollar first-of-a-kind plants. Yet, as natural petroleum becomes less plentiful and more expensive, oil made from abundant coal could someday become an increasingly important energy option. To prepare for that day, the US government is working with private industries and universities to establish a sound base of technical knowledge in coal liquefaction.

4284 **(DOE/MC/16310—1493) Stochastic study of local fluctuations around the distributor in a fluidized bed gasifier. Final report, April 16, 1981-April 15, 1983.** Fan, L.T. (Kansas State Univ., Manhattan (USA). Dept. of Chemical Engineering). 29 Sep 1983. Contract AC21-81MC16310. 313p. NTIS, PC A14/MF A01. Order Number DE84000224.

The work accomplished during the contract period (April 16, 1981 to April 15, 1983) for the project is reported. The objective of this research was to determine local and fluctuating phenomena around the distributor of a fluidized bed gasifier by means of on-line and off-line correlation methods. The briefs of the work accomplished are stated in the text and the details are given in APPENDICES A, B, C, D, E, F, G, H, I and J. 39 references.

4285 **(DOE/METC/SP—198) Advanced gasification projects.** (USDOE Morgantown Energy Technology Center, WV). Feb 1983. 66p. NTIS, PC A04/MF A01. Order Number DE84000215.

This report describes the results and accomplishments of the Morgantown Energy Technology Center's (METC) research and development program in surface coal gasification from October 1, 1981, to September 30, 1982. The primary goal of the program is to advance surface coal gasification technology through basic, exploratory, and applied research and development activities at various research organizations in the private and public sectors. The major thrust of the program is the advancement of a fundamental scientific and engineering data base to provide innovative concepts and ideas for coal gasification and associated technologies. The objectives of the program are: to derive new fundamental information and concepts about coal structure and the physical and chemical mechanisms whereby these structures undergo devolatilization and gasification; to examine innovative concepts for improved efficiency and economics of chemical and physical methods of gas separation and treatment to remove undesired components and recover pure gaseous components; and to develop mathematical models, based on fundamental principles, that can be used to predict and simulate behavior of gasification and other subsystems under new conditions.

4286 **(DOE/OR/03054—78) Forest communities of the SRC-I demonstration plant site and the surrounding area. Final technical report.** Martin, W.H. (International Coal Refining Co., Allentown, PA (USA)). Oct 1983. Contract AC05-78OR03054. 74p. NTIS, PC A04/MF A01. Order Number DE84003177.

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In 1981 and 1982, the vegetation of the proposed SRC-I Demonstration Plant site and surrounding area was documented. General land vegetation categories were recognized and mapped, and specific plant communities in selected forested systems were mapped and described. In summary: All forests of the study area are at least second-growth, and most have been logged more than once, with varying intensity. Other known current disturbances such as grazing and impoundment by beavers are changing forest composition. Vegetation-Habitat Reference Maps provide data on nine general land categories: cropland, pasture and grass, old fields, thickets, small groves and lines of trees, open bottomland deciduous forests, closed bottomland and deciduous forests, open upland deciduous forests, closed upland deciduous forests. Cropland constitutes at least 75% of the hectareage at the plant site and of the bottomland in the vicinity. Specific habitat information recorded on the Vegetation-Habitat Reference Maps provides useful reference points for studies of animal populations. Over 120 notes have been included on the reference maps. In all, 95 permanent plots have been established in five forested areas: 24 in Martin Creek, 22 in Richland Slough, 18 on upland slopes at Pleasant Hill Church, 13 and 12 in the eastern and western sections of Sloughs Wildlife Management Area, respectively, and 6 on the banks of the Green River at the demonstration plant site.

4287 **(DOE/PC/40785—9) Exploratory study of coal conversion chemistry. Quarterly report No. 9, May 19, 1983-August 18, 1983.** Ross, D.S.; McMillen, D.F.; Ogler, W.C.; Chang, S.J.; Hum. G.P.; Mansani, R.; Green, T.K. (SRI International, Menlo Park, CA (USA)). Sep 1983. Contract AC22-81PC40785. 27p. NTIS, PC A03/MF A01. Order Number DE84003112.

Work has begun on computer modeling of hydrogenolysis systems, incorporating the hydrogen transfer reactions we have invoked to explain the liquefaction effectiveness of pyrene. Additional coal conversion experiments have also been performed in a not yet successful attempt to clearly define the conversion conditions under which the differences between pyrene and the other solvents are maximized. We are also conducting a series of experiments designed to relate conversion in pure model compound systems to conversion in real coal systems and to further characterize certain coals for their radical-initilating and hydrogen transfer properties as compared with pure donor solvent systems. These latter experiments involve spiking coal liquefaction mixtures with model compounds under conditions where conversion of the model compounds can readily be determined. Our efforts in Conversion in CO/H_2O Systems were concentrated on analysis of the conversion products of an Illinois No. 6 coal, PSOC-1098, in CO/D_2O were analyzed for their deuterium content; the results reveal substantial levels of deuterium incorporation, even in the absence of conversion. Hence, supercritical water exchanges rapidly and extensively with coal at 400°C. The behavior of benzaldehyde in CO/H_2O and CO/D_2O was also examined. The reduction of benzaldehyde to benzyl alcohol follows the water-gas shift reaction and exhibits an inverse isotope effect. This behavior is similar to the conversion behavior of the Illinois No. 6 coal in CO/H_2O. Evidence is also presented that supports the view that formate, the intermediate in the water-gas shift reaction, is responsible for conversion of the Illinois No. 6 coal.

4288 **(DOE/PC/50786—6) Facile reaction/extraction of coal with supercritical fluids. Quarterly technical progress report, July 1, 1983-September 30, 1983.** Venier, C.G.; Squires, T.G. (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). 23 Nov 1983. Contract FG22-82PC50786. 6p. NTIS, PC A02/MF A01. Order Number DE84002945.

Initial attempts to solubilize coal by phenylation have been unsuccessful. On the basis of these results and the fact that model polymers are solubilized, one is led to two possible conclusions, namely: (1) The functional groups in the model systems, phenyl alkyl ethers and diaryl methanes, do not occur to any significant extent in coal, or (2) Retrogressive reactions which repolymerize coal occur under the phenylation conditions. In view of many other studies demonstrating the presence of ether and methylene linkages in coal and their importance in coal pyrolysis, the first conclusion hardly seems tenable. Our own work shows that, even in low concentration, naphthalene and phenol can compete successfully with benzene under the phenylation conditions. Other aromatic residues in coal may also undergo similar reactions; and in addition, relinking reactions of an unknown nature may be taking place. One likely reaction is the Scholl reaction, which links aryl systems directly to one another. Investigations of the structure of solid products of the coal phenylation reaction should provide clues as to the nature of these counterproductive reactions.

4289 **(DOE/PC/50798—5) Catalyzed gasification of coal: isotope and XPS studies.** Falconer, J.L. (Colorado Univ., Boulder (USA)). 22 Nov 1983. Contract FG22-82PC50798. 6p. NTIS, PC A02/MF A01. Order Number DE84003898.

This research aims to elucidate the reaction mechanism for the catalytic gasification of coal by metal carbonates, by identifying the reaction pathways and the active form of the catalyst. The insight into the mechanism will help in improving process kinetics of coal gasification. Alkali carbonates and alkaline earth carbonates are being used to catalyze the carbon dioxide-carbon gasification reaction. Temperature-programmed reaction, isotopic labeling of the carbon and oxygen atoms in the carbonate, and mass spectrometric detection of labeled products are used to identify reaction pathways. X-ray photoelectron spectroscopy (XPS) analysis of carbon-carbonate mixtures is used, at reaction conditions, to determine the chemical state of the carbonate.

4290 **(DOE/PC/50799—T2) Enhanced coal liquefaction by hydropyrolysis in supercritical fluids. Quarterly report, July-September 1983.** Paulaitis, M.E.; Klein, M.T.; Stiles, A.B. (Delaware Univ., Newark (USA). Dept. of Chemical Engineering). 1983. Contract FG22-82PC50799. 18p. NTIS, PC A02/MF A01. Order Number DE84002139.

This research program involves a fundamental investigation of a novel coal liquefaction process that combines pyrolysis, supercritical-fluid solvent extraction, and in situ hydrogen generation through catalytic dissociation of methanol. The experimental work consists of determining: (1) coal pyrolysis reaction pathways, kinetics and mechanisms, and the identity and structure of reaction intermediates, (2) solubilities of coal-derived species in supercritical water, methanol, and water + methanol mixtures, and (3) reaction pathways involved in the generation of hydrogen by catalytic dissociation of methanol to carbon monoxide and hydrogen, and through the shift of carbon monoxide. Both model coal compounds and actual coals are to be studied. 4 figures, 8 tables.

4291 **(DOE/TIC—3400) Coal desulfurization: a bibliography.** Grissom, M.C. (ed.). (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Oct 1983. 511p. NTIS, PC A22/MF A01. Order Number DE83017757.

Annotated references are listed for 2139 publications on coal desulfurization, cleaning, and upgrading. Five indexes are included with a brief description of each: Corporate Author, Personal Author, Subject, Contract Number, and Report Number.

4292 **(MLM—3116(OP)) Design considerations and systematic operation of an underground coal gasification process.** Agarwal, A.K.; Zielinski, R.E. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1983. Contract AC04-76DP00053. 27p. (CONF-831063—8). NTIS, PC A03/MF A01. Order Number DE84002838.

From American Institute of Chemical Engineers fall annual meeting; Washington, DC, USA (30 Oct 1983).

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A commercial Underground Coal Gasification (UCG) process could roughly quadruple the 450 billion tons of US coal reserves which are presently recoverable by mining. An UCG field test in a swelling bituminous coal was successfully completed near Pricetown, West Virginia. Instrumentation and a sample handling system designed for real time analysis and control worked well in capturing all the data to accurately analyze the process in spite of the wide variations in the process conditions and product composition. Approximately 702 tons of coal was affected during the test. During the gasification phase, a gas with an average heating valuw of 126 Btu/scf (4695 kJ/m^3) was produced with only air injection, which resulted in an average energy production of 362 MMBtu/day (382 GJ/d). The percent energy recovery for the gasification phase was 72%. The data obtained from this test have been used to design an effective program that can lead to a commercial demonstration and subsequently, commercial acceptance of this technology for bituminous coals by the early 1990's. 10 references, 6 figures, 4 tables.

4293 **(NERDDP-EG—80-2) The effect of temperature and atmosphere carbonising of Collie coal as regards the properties of formed coke produced from the char.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Collie coal chars were used to make briquettes using a petroleum bitumen binder. Chars prepared in carbon dioxide were significantly weaker in strength compared to those prepared in nitrogen. Aspects of char properties in relation to methods of carbonisation are discussed with particular reference to the rinsing gas retort.

4294 **(NERDDP-EG—81-21) Synthetic coking components from coal.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

This article reviews, analyses, and assesses solvent refined coal (SRC) with most emphasis on relevant hydroliquefaction technology. SRC can be used directly as a boiler fuel, as a significant coking component, as a source of electrode carbons and as the feedstock of proven liquefaction processes. The technology of SRC production embodies all hydroliquefaction operations and is special to emerging industries. Various development projects are looked into. They include Exxon Donor Solvent, Sasal SRC, Mitsui SRC, CSF Cresap, Sumitomo STC, Lummus CFFC, Kominic etc.

4295 **(NERDDP-EG—82-42) Studies on the reactivity of chars derived from various coal conversion process conditions.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

A detailed literature survey on all aspects relevant to the reactivity of coal derived chars to carbon dioxide has been conducted. Experimental facilities have been constructed and commissioned to measure the reactivity of chars to gases. A method of producing chars has been developed that minimises the agglomeration problems encountered. Chars from a series of Australian coals have been prepared by this method in several size ranges. It is proposed to study their reactivity to CO_2 over a range of temperatures and to correlate the data with the chemical and physical properties of the chars including the influence of their mineral constituents.

4296 **(PNL-SA—11552) Advanced techniques in synthetic-fuels analysis.** Wright, C.W.; Weimer, W.C.; Felix, W.D. (eds.). (Pacific Northwest Lab., Richland, WA (USA)). 1983. Contract AC06-76RL01830. 421p. (CONF-811160—). NTIS, PC A18/MF A01. Order Number DE83015528.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

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A symposium on the Chemical Characterization of Hazardous Substances in Synfuels was held at Seattle, Washington, November 2-4, 1981. It was sponsored by the Office of Health and Environmental Research, Office of Energy Research, US Department of Energy and the Pacific Northwest Laboratories, Battelle Memorial Institute. Twenty-two papers have been entered individually into EDB and ERA. (LTN)

4297 (PNL-SA—11552, pp 3-11) **Improved procedure for extraction of aromatic bases from synfuel materials.** Boparai, A.S.; Haugen, D.A.; Suhrbier, K.M.; Schneider, J.F. (Argonne National Lab., IL). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract W-31-109-ENG-38.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The present study was undertaken to evaluate the conventional aqueous acid-base extraction procedures and to explore alternative conditions for optimizing recovery of aromatic bases, some of which are important contributors to mutagenicity of synfuel sam-

ples. A standard mixture containing phenols, polynuclear aromatic hydrocarbons, primary aromatic amines (PAA), and azaarenes (AA), representative of the types of compounds found in synfuel mixtures, was separated by four different acid-base extraction procedures. Recoveries of the 13 compounds in the acid, base, and neutral fractions were determined by gas chromatography. The results demonstrated that use of methanol as a cosolvent dramatically increased recoveries of hydrophobic 3- to 5-ring PAA and AA and eliminated the formation of emulsions during extraction of coal-derived materials. The modified extraction procedure is superior to commonly used batch extraction procedures in two ways: (a) much higher extraction efficiencies are achieved for larger polynuclear aromatic amines and azaarenes, and (b) formation of emulsions is avoided in the extraction of bases from synfuel samples.

4298 (PNL-SA—11552, pp 12-23) **Fractionation of coal tar from low Btu gasification.** Dutcher, J.S.; Royer, R.E.; Mitchell, C.E.; Dahl, A.R. (Inhalation Toxicology Research Inst., Albuquerque, NM). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC04-76EV01013.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The purpose of this work was to develop fractionation procedures appropriate for identifying components of coal gasifier tar and also for concentration and testing of biological activity. This scheme was characterized both by using standards and also by fractionating coal tar and determining the types of compounds which eluted into each fraction. Tar trap tar was especially difficult to fractionate for several reasons. It had low solubility in organic solvents which were immiscible in water and formed an intractable precipitate on contact with an aqueous phase, making aqueous-organic partition impractical for primary fractionation. Further, when the portion of the tar which was soluble in organic solvents was chromatographed on silica or alumina, recoveries were low due to permanent retention of some of the material. Chromatography on Sephadex LH-20 with THF as an eluent proved to be a mild, high recovery (100%) technique for initial fractionation of tar trap tar. Quantities of 500 mg of tar were fractionated by this procedure, giving enough material in each fraction for analysis and further subfractionation. Different organometallic standards eluted in different fractions when chromatographed on Sephadex LH-20. Greater than 62% of the mass of the coal tar examined in this study was in fractions which were not gas chromatographable. These fractions probably contain high molecular weight, polar, and/or thermally labile compounds. Other methods besides GC/MS are necessary to characterize these materials. In summary, a multistep fractionation scheme has been devised which is useful for fractionaton of coal gasifier tar. Using this scheme, this tar has been shown to be a complex mixture consisting of high molecular weight materials, several classes of organic compounds, and THF-soluble metallic compounds.

4299 (PNL-SA—11552, pp 24-43) **Isolation and identification of bioactive constituents in synfuels.** Ho, C.H.; Guerin, M.R.; Buchanan, M.V. (Oak Ridge National Lab., TN). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract W-7405-ENG-26.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Results of these studies and those of others (17,18) show that polar substituted polycyclic aromatic compounds cause the bacterial mutagenicity of synfuels. Mutagenicity is found to decrease upon hydrotreatment for the synfuels even though polycyclic aromatic hydrocarbon content increases. The distribution of mutagenicity by chemical class is similar for shale and coal oils. A direct comparison of the Ames mutagenicity and mouse skin tumorigenicity of neutral subfractions of two coal-derived samples indicates that Ames testing is not necessarily a suitable predicator for skin carcinogenicity. Diethylether and isooctane used as acid/base/neutral partition solvents for chemical class separation provide compatible results regarding the distribution of mutagens.

4300 (PNL-SA—11552, pp 44-73) **Chromatographic methods for the chemical and biological characterization of polycyclic aromatic compounds in synfuel materials.** Later, D.W. (Pacific Northwest Lab., Richland, WA); Lee, M.L. 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC02-79EV10237.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

In summary, conversion of coal of energy-related products results in materials that are highly aromatic in chemical composition. Methods for the class separation and detailed identification of isomeric PAH and analogous heterocyclic PAC have been described. The adsorption column chromatographic and chemical modification procedures discussed provide excellent separation of PAC in crude samples according to chemical functionality. Capillary column gas chromatography and ancillary techniques permit the detailed chemical characterization of isomeric PAH, PASH, N-PAC, and 0-PAC. The routine application of these analytical methods is currently aiding in the accurate assessment of environmental hazards and process logistics for coal-derived synthetic fuels.

4301 (PNL-SA—11552, pp 74-94) **Role of partition chromatography/HPLC in the organic and mutagenic characterization of synfuels.** Toste, A.P.; Sklarew, D.S.; Pelroy, R.A. (Pacific Northwest Lab., Richland, WA). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC06-76RL01830.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Of all the synfuel samples analyzed, the oil shale retort waters were least mutagenic; all of the mutagenicity of the retort waters was confined to the hydrophobic organic fraction. The Paraho shale oil was significantly more mutagenic than the crude, unfractionated retort waters. The absence of appreciable mutagenicity in the shale oil Sephadex LH-20 hexane fraction indicates that nonpolar species do not contribute to the shale oil's mutagenicity, at least at this level of HPLC fractionation. The presence of mutagenicity in the shale oil's moderately polar and polar HPLC regions indicates that the mutagens are chemically heterogeneous. The SRC-II distillate blend differed from the shale oil in a number of ways. The distillate blend proved to be much more mutagenic than the shale oil. Furthermore, the mutagenic profiles of the distillate blend after HPLC fractionation were quite different than those of the shale oil. Unlike the shale oil, the distillate blend contains nonpolar mutagens which are unmasked by HPLC fractionation. Likely candidates for these nonpolar mutagens are polynuclear aromatic hydrocarbons and nonpolar heterocycles. In contrast to the shale oil, the distillate blend's moderately polar mutagens are confined to a single HPLC fraction in the moderately polar HPLC region, indicating that the distillate blend's mutagens are much less heterogenous than the shale oil's mutagens.

4302 (PNL-SA—11552, pp 95-101) **Summary of separation and fractionation methodologies with future directives.** Lee, M.L.; Bechtold, B.; Boparai, A.S.; Later, D.W.; Ho, C.; Spall, D.; Toste, A.P.; Wozniak, T.J. (Brigham Young Univ., Provo, UT). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The following list is an attempt to summarize the conclusions and recommendations: (1) for biological testing, minimum fractionation is most desirable in order to provide the most accurate elevation of the biological activity of the real sample. On the other hand, more extensive fractionation may be required for detailed chemical characterization; (2) at present, relatively few valid comparisons (both chemical and biological determinations) can be made between laboratories because of the lack of standardized analyses; (3) three standard reference materials are proposed for interlaboratory comparison: petroleum crude, shale oil, and coal liquid; (4) sample storage conditions should be standardized to include storage in dark glass containers (for organics, plastic for inorganic) with teflon liners, in the dark, under nitrogen, at 4°C; and (5) standard-

ized analyses should be reported for each sample: CHNOS elemental analysis; neutron activation analysis for metal content; simulated distillation resulting in a plot of percent recovered vs. temperature; HPLC fractionation of the sample on a bonded NH_2-column into nonpolar (hexane mobile phase), and polar (isopropanol mobile phase) fractions. Mass balance, compound distribution and biological test data should be reported. An effort should be made to compile a comprehensive list of compounds identified in synfuels and by-products. Future efforts should be directed toward developing fractionation and analysis methods for extremely polar compounds and compounds of high molecular weight.

4303 (PNL-SA—11552, pp 105-132) **Environmental characterization of the Hygas process.** Anastasia, L.J. (Inst. of Gas Tech., Chicago, IL). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The HYGAS process is a second-generation coal gasification technology that uses stagewise fluidized-bed hydrogasification at elevated pressures to produce a substitute natural gas which is essentially all methane. Process development has been studied in the HYGAS pilot plant, which has a design capacity of 3 tons/h coal feed to the gasifier. The main processing steps in the pilot plant consist of coal pretreatment, gasification, gas purification (acid-gas removal), and methanation. The environmental assessment of the process is focused on two portions of the pilot plant (pretreatment and gasification) considered scalable to larger plant designs. A scalable unit is defined as an existing pilot plant unit that will have a counterpart in demonstration or commercial HYGAS plants. The pilot plant has operated successfully with several types of coal-lignite, subbituminous, and bituminous. For gasification, only bituminous coals require pretreatment, which is a mild surface oxidation to destroy any tendencies of the coal to agglomerate during gasification. This chapter describes the environmental data base obtained in gasification tests with washed, pretreated, Illinois No. 6 bituminous coal from Peabody Mine 10. Pretreatment involves a mild surface oxidation of the coal at atmospheric pressure, which inhibits the tendency of bituminous coal particles to cake. The pretreater reactor is operated at the temperatures, residence times, and air and steam rates given.

4304 (PNL-SA—11552, pp 133-144) **Identification of components of biologically active fractions of low Btu gasifier coal tars.** Dutcher, J.S.; Royer, R.E.; Hill, J.D.; Mitchell, C.E.; Hanson, R.L. (Lovelace Inhalation Toxicology Research Inst., Albuquerque, NM). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC04-76EV01013.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Total mutagenicity was highest in the PAH containing fraction 3 + 4 from the Sephadex LH-20 chromatography fractionation. This was not surprising since many of these chemicals have been shown to be mutagenic. Significant mutagenicity was also found in the fraction containing polar substituted PAH (fraction 5). The basic compounds in this fraction contributed slightly less to its mutagenicity than neutral/phenolic compounds. Cytotoxic activity was generally found in the same fractions as mutagenic activity. One exception was that acidic material (fraction 5, acid subfraction) was cytotoxic but not mutagenic. Identification of compounds in this study relied on GC and GC/MS analyses. Compounds which were not gas chromatographable (due to molecular weight, thermal instability or polarity) were not characterized. Due to the complex nature of the tar and its fractions and the limitations of in vitro assays, it is difficult to extrapolate these results directly to mammalian systems.

4305 (PNL-SA—11552, pp 160-177) **Characterization of lignite liquefaction products.** Olson, E.S.; Farnum, S.A.; Farnum, B.W.; Miller, D.J.; Diehl, J.W.; Bitzan, E.F. (Grand Forks Energy Technology Center, ND). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The Grand Forks Energy Technology Center is investigating the conversion of lignite and other coals to distillable liquid products using synthesis gas. A slurry of coal in a recycled, heavy liquid product was heated to 460°C with various reducing-gas mixtures at pressures from 2000 to 4000 psi in a continuous-flow reactor. This produced a volatile product which was condensed at 300°C and 27.5 MPa to form a light oil. These light oil products as well as the heavy material which did not vaporize has been the subject of analytical investigations. A description of the separation and identification methods used is presented using data from various liquefaction experiments. The light oils and vacuum-distilled heavy liquid products have been subjected to several types of chromatographic separations. The aliphatics, aromatics, and polars were clearly separated, however, good resolution of the different aromatic types was not obtained; e.g., the naphthalenes, which were present in large amounts in the samples, gave an overlapping elution with other aromatic classes. Good recoveries were obtained (>90%) and sufficient material was found in most of the fractions for proton and carbon NMR analyses. The dual alumina-silica gel open column method (2) has also been used in the analyses of light oil products. Two different size columns have been used. The separation of aliphatics, aromatics, and polars was easily obtained and the aromatics were well resolved into classes of monoaromatics, diaromatics (naphthalenes, acenaphthenes, and biphenyls), and polynuclear aromatics.

4306 (PNL-SA—11552, pp 201-214) **Biodirected chemical characterization of synfuel materials.** Stamoudis, V.C.; Haugen, D.A.; Peak, M.J.; Wilzbach, K.E. (Argonne National Lab., IL). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract W-31-109-ENG-38.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

An important requirement for understanding the health and environmental hazards of synthetic fuels is the ability to attribute toxicological activity to specific chemicals present in the complex synfuel mixtures. This has most often been achieved by assaying toxicological activity [usually mutagenicity as measured in the Ames assay] of various fractions of the synfuel mixtures. An iterative scheme is used whereby the most toxicologically active fractions are successively subfractionated, so that relatively simple mixtures of chemicals are obtained that have a substantial portion of the toxicological activity. Such fractionation procedures allow the toxicological activity to be attributed to certain classes or subclasses of chemicals. This approach has been termed biodirected chemical characterization and is essential for understanding the toxicological properties of complex coal-derived mixtures. The work done at Argonne National Laboratory (ANL) in which biodirected chemical characterization was used to isolate mutagenic aromatic amines in samples from DOE-sponsored high-Btu coal gasification pilot plants and comparable research material from a liquefaction process is summarized. The Ames mutagenicity assay was the only measure of biological activity.

4307 (PNL-SA—11552, pp 215-230) **Chemical characterization of organic constituents in groundwater near an underground coal gasification site.** Stuermer, D.H.; Ng, D.J.; Morris, C.J. (Lawrence Livermore National Lab., CA). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract W-7405-ENG-48.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Lawrence Livermore National Laboratory has conducted three underground coal gasification experiments to explore this promising technology. The experiments were conducted at the Hoe Creek site in the Powder River Basin in northeastern Wyoming. The investigation of environmental concerns associated with this technology has been an important part of this program. One of the major concerns is the contamination of groundwater by residual by-products of the gasification process. The composition of the dissolved organic component of the contamination generated by UCG activities and that which has persisted as dissolved compounds in the local groundwater since completion of the gasification experiments is described in this chapter. The composition of the organic

compounds in the groundwater appears to be controlled, after deposition, by partitioning of more complex organic mixtures between the water and the aquifer substrate. A simplified method of extraction and analysis designed for the composition observed is presented and a selection of specific compounds that can be used as monitoring indicators for the presence of UCG contaminants in groundwater samples is suggested.

4308 (PNL-SA—11552, pp 231-250) **Heteroatomic polycyclic aromatic hydrocarbons in coal liquids.** Wilson, B.W.; Pelroy, R.A.; Mahlum, D.D.; Frazier, M.E.; Wright, C.W. (Pacific Northwest Lab., Richland, WA). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC06-76RL01830.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Results of the in vitro tests and the initiation/promotion assay generally showed the same trends. The major exception overall was the failure of the standard Ames assay to respond to the PAH fraction and the enhanced response of the Ames assay to lower molecular weight APAH in the basic fraction. Caution must be exercised in using the in vitro results to predict the carcinogenic potency of the materials. The basic fraction is more active than the PAH fraction in the Ames test, less active than the PAH fraction in the SHE cell assay, and about equally as active as the PAH fraction as obtained by solvent fractionation in the initiation/promotion assay. The results of the initiation/promotion assays indicate that more than one chemical class contributes to the carcinogenicity of coal-derived liquids. The data suggest that the carcinogenic activity is better segregated by fractional distillation than by solvent fractionation; also that employment of a battery of in vitro assays increases the chances of successfully predicting the carcinogenicity of crude mixtures. The working hypothesis is that the in vitro tests for mutagenicity described are sensitive to events which are probably analogous to the initiation step in the initiation/promotion model for carcinogenesis. Amino-PAH appear to be active at relatively lower molecular weights than do the PAH species in the coal liquids. Concentrations of nitrogen-containing compounds (including APAH) appear to correlate to the response for most of the in vitro results in these limited studies. The general body of data on chemical carcinogenesis is therefore being looked at to determine if heteroatomic species, such as nitrogen containing polyaromatic compounds, may be more important in the health and environmental effects of hydrocarbon pollutants than heretofore appreciated.

4309 (PNL-SA—11552, pp 269-285) **Measurement of nitrogenous and sulfurous combustion emissions.** Brown, N.J.; Cuellar, E.; Lucas, D. (Lawrence Berkeley Lab., CA). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC03-76SF00098.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Aspects of this research concerned with the measurement of nitrogenous and sulfurous compounds important in the combustion of synthetic fuels are presented and discussed. The measurement of species in combustion environments presents a host of specialized problems to the researcher, namely: (a) potential interference problems associated with high concentration of H_2O and CO_2; (b) possible reactions in sampling systems; and (c) the problems associated with high temperature and atmospheric pressure calibrations. Research will continue to overcome these problems for specific molecules. The current work, which has been largely concerned with the measurement of inorganic species, will be gradually redirected toward the measurement of organic species which play a role in soot formation.

4310 (PNL-SA—11552, pp 286-298) **Comparative spectroscopic characterization of synthetic-fuels.** Buchanan, M.V.; Guerin, M.R.; Kao, G.L.; Rubin, I.B.; Caton, J.E. (Oak Ridge National Lab., TN). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract W-7405-ENG-26.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

A variety of spectroscopic methods have been used to distinguish isomeric compounds in complex mixtures and to predict trends in bacterial mutagenic activity. Chemical ionization mass spectrometry using methanol and ammonia as ionization reagents have been used to yield unambiguous identifications of aromatic oxygen and nitrogen-containing compounds, respectively. Fluorine NMR of derivatized aromatic amines has been used to compare relative amounts of primary, secondary N-alkyl and secondary heterocyclic amines in complex mixtures. Finally, both proton NMR and infrared spectroscopy have been investigated as means of predicting trends in bacterial mutagenic activity. The proton NMR method shows a good correlation of higher aromatic content with mutagenic activity of fossil fuels. The infrared method shows that a band at 1600 cm^{-1} arising from C=O, C=N, C=C, N=O, and hindered NH and OH yields the best correlation with mutagenic activity.

4311 (PNL-SA—11552, pp 317-331) **Laser excited Shpol'skii spectrometry (less) for the direct determination of polynuclear aromatic hydrocarbons in liquid fuels.** D'Silva, A.P.; Fassel, V.A.; Yang, Y.; Iles, M. (Iowa State Univ., Ames). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract W-7405-ENG-82.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

In this chapter it is shown that tunable, dye laser excitation of Shpol'skii effect spectra provides a very useful means of determining PAH compounds directly in coal liquids and shale oil without prior isolation of the PAH fraction by chromatographic or other techniques. Although the characteristic ultraviolet and laser excited optical luminescence of PAH has been advocated and utilized for the sensitive detection of these compounds, the fluorescence and phosphorescence spectra of these compounds are quite broad at room temperature (~ 25°C), having full widths at half maximum (FWHM) of the order of 300 cm^{-1}. As a consequence, ambient temperature luminescence techniques have been utilized to a limited extent in the characterization of highly complex coal liquids for PAH. To overcome this limitation, the sharpening of the luminescence spectra observed when these molecules are incorporated in appropriate matrices and solidified at low temperatures has been utilized in the development of several ultraviolet, x-ray excited and laser excited techniques. These techniques have been based on: (a) the Shpol'skii effect; (b) matrix isolation (MI); and (c) fluorescence line narrowing spectrometry (FLNS) in organic glasses. The selectivity of the Shpol'skii effect lies in the inherent sharp absorption bandwidths exhibited by PAH in appropriate frozen n-alkane hosts. Because of the selectivity of laser excited Shpol'skii spectra (LESS), their observation in either the frozen solution or MI mode possess attractive advantages for the direct characterization of very complex mixtures. Of the two modes of operation, the preparation of frozen solutions is a simpler process and more readily adaptable to quantitative transfer than the MI alternative.

4312 (PNL-SA—11552, pp 332-352) **New approaches combining chromatography and mass spectrometry for synfuel analysis.** Smith, R.D. (Pacific Northwest Lab., Richland, WA). 1983. NTIS, PC A18/MF A01. (CONF-811160—). Contract AC06-76RL01830.

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The need for improved methods for the separation, characterization and quantitation of samples containing highly polar, nonvolatile, and thermally unstable molecules is well recognized. This need is particularly great in the analysis of complex synthetic fuel samples. This need has resulted in the development of an array of new mass spectrometric methods based around ion or neutral desorption processes. Field desorption (FD) mass spectrometry is effective for the analysis of many such compounds but a direct interface between the liquid chromatograph and the FD mass spectrometer has not been constructed due to the high voltages and precise mechanical alignment required. Recently, it has been recognized that a variety of alternate ionization methods produce mass spectra which are similar to those obtained by field desorption. These techniques include in-beam chemical ionization on Teflon probes or spe-

cial surfaces, secondary ion mass spectrometry (SIMS), fast atom bombardment (FAB), Californium-252 plasma desorption, laser desorption, and a variety of rapid heating methods. These methods can provide the basis for combined high performance liquid chromatography HPLC/mass spectrometry. The interfacing of a particle bombardment ionization method for HPLC/MS is described and the advantages and disadvantages of this approach are discussed. More recently, it has been recognized that an alternative approach using conventional electron impact or chemical ionization methods can be utilized if the nonvolatile or labile molecules were efficiently transferred to the gas phase. PNL has been involved in the development of new instrumentation combining both HPLC and supercritical fluid chromatography with mass spectrometry.

4313 **(SAND—83-1875) Coal liquefaction process research. Quarterly report, April 1-June 30, 1983.** Chapman, R.N.; Lynch, A.W.; Padrick, T.D.; Stephens, H.P.; Stohl, F.V. (Sandia National Labs., Albuquerque, NM (USA)). Nov 1983. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01. Order Number DE84003513.

This quarterly report for the period April through June 1983 summarizes activities in Sandia National Laboratories' continuing program of research on direct coal liquefaction. The program, composed of two projects - Advanced Concepts for Multistage Coal Liquefaction and Catalyst Studies in Coal Liquefaction - has as its overall goals to provide an understanding of the mechanisms and kinetics of primary and secondary reactions in coal liquefaction; to explore advanced concepts for multistage processing; and to determine the effect of process variables on catalyst deactivation. During this period, work was performed on: microreactor experiments with Wyodak coal and model solvents with hydrogen donor and/or basic nitrogen properties to study the role of hydrogen bonding in dissolution of subbituminous coals; continued testing of the continuous flow reactor for determination of catalyst deactivation; construction and testing of a high pressure model compound testing unit; definition of a model which accurately represents the heterogeneous catalytic hydrogenation of pyrene; microreactor experiments to explore the role of hydropyrenes as sources of hydrogen in hydrogenolysis; kinetics of the dissolution of Kentucky No. 9 coal in phenanthrene at 320°C in the atmospheric ebullated coal bed/solvent extraction apparatus; determination of metal concentrations, surface areas and pore volumes of catalyst samples from Wilsonville; determination of cracking, hydrodesulfurization and hydrogenation activities of catalyst samples from the Integrated Two Stage Liquefaction pilot plant; and shakedown of the atmospheric model compound testing unit. 1 reference, 17 figures, 7 tables.

4314 **(SAND—83-2041) Process and technology development activities for in situ coal gasification, FY83.** Glass, R.E. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Dec 1983. Contract AC04-76DP00789. 73p. NTIS, PC A04/MF A01. Order Number DE84003971.

As part of DOE's Underground Coal Gasification Program, activities at Sandia National Laboratories have been directed at Process and Technology Development. The project areas include (1) the development of a cornering water jet drill for use in linking vertical wells in Underground Coal Gasification (UCG) tests; (2) the development of a controlled source audio-frequency magnetotelluric (CSAMT) surface geophysical technique for monitoring the process, and (3) the development of models for use in predicting surface subsidence and cavity growth. The accomplishments for the year include (1) the successful completion of the high wall tests of the cornering water jet drill, (2) the start of the down hole tests including completion of the vertical hole and underreamed volume, testing of the sump pump and initial drilling to a hole length of three meters, (3) the preliminary CSAMT survey of the Tono partial seam controlled reacting injection point (CRIP) test area, (4) the development of a data acquisition and analysis system for the CSAMT technique, (5) the development of a predictive model for subsidence and cavity growth and their application to the partial seam CRIP test.

4315 **(TENRAC/EDF—098) Determination of pyrolysis kinetic parameters of San Miguel (Texas) lignite. Final report.** Mann, U.; Selim, S.; Jih, J. (Texas Tech Univ., Lubbock (USA). Dept. of Chemical Engineering). Jun 1982. 115p. NTIS, PC A06/MF A01. Order Number DE84900432.

The thermal decomposition of lignite in the absence of oxygen (pyrolysis) is important as a part of processes for converting lignite to more desirable fuels or for recovery of energy from deep basin lignite. The pyrolysis reaction kinetics of San Miguel (Texas) lignite has been experimentally studied in the temperature range 650 to 800°C at atmospheric pressure. Gas and tar produced were collected and measured, and weight change as a function of time was measured. Lignite decomposition into gas, tar, and char can be described by three parallel first order reactions. In the temperature range investigated, the rates of pyrolysis are controlled by intraparticle transport phenomena. A simplified kinetic-transport model was used to estimate the individual reaction rate constants and activation energies. The gas produced was found to consist primarily of carbon dioxide, carbon monoxide, and hydrogen, with some methane, ethane, ethylene, and a trace C_3 compounds. Sample temperature increases and theoretical calculations indicate that oxygen from the lignite structure may be oxidizing lignite or pyrolysis products. It is recommended that, after suitable equipment modifications, the investigation be extended to study combined oxidation and pyrolysis of lignite.

4316 **(UCRL—50026-83-2) LLNL underground coal gasification project. Quarterly progress report, April-June 1983.** Stephens, D.R.; Clements, W. (eds.). (Lawrence Livermore National Lab., CA (USA)). 23 Aug 1983. Contract W-7405-ENG-48. 27p. NTIS, PC A03/MF A01. Order Number DE84003334.

The products of coal pyrolysis play an important part in determining the ultimate products - especially the hydrocarbons - recovered from an underground coal gasification (UCG) system. Thus some type of pyrolysis submodel is necessary to successfully model a UCG system. Recently we have done a series of experiments to provide more realistic pyrolysis data. In these experiments, coal is continuously fed onto a hot bed of char, and the pyrolysis products are swept down through the hot char before being removed from the reactor. The experiments have been done at various temperatures and pressures (500 to 900°C and 100 to 600 kPa). Methane production was found to reach a peak at 800°C and the effect of the modest pressure change from 100 to 600 kPa was small. The methane produced is threatened by system temperatures much above 800°C. Another part of the UCG modeling problem is in simulating the growth of the burn cavity. We have improved our cavity growth model by incorporating in it many of the key features observed in the large block (LBK) experiments done near Centralia, Washington, in 1981-1982. The model divides the cavity into three zones consisting of ash, rubble, and void, with provision for movement of solids between zones. Roof and walls of the cavity regress at rates dependent on fluid velocities and temperatures. The fluid velocities are determined by cavity geometry in conjunction with calculated temperatures and injection rates, assuming Darcy flow in a nonisotropic permeable medium. The fluid velocities along with the rubble-forming rates are input to a chemical/thermal model which determines product composition and cavity temperature. We have made a number of runs with our improved cavity growth model, matching LBK data, studying sensitivity to variations in model parameters and operational parameters, and calculating the possible performance of the upcoming Centralia partial-seam CRIP test.

0105 By-products

REFER ALSO TO CITATION(S) 4294, 4298, 4304

4317 **(NERDDP-EG—81-32) Lubricating oil from low temperature coal tar.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Two coals from the Hunter Valley region of New South Wales, and one from Queensland were each carbonized at 500 C in a laboratory scale fluidized bed reactor. The tars produced were examined with a view to producing a lubricating oil stock. The viscosity indices were comparable with those produced from petroleum sources. Structural testing using nuclear magnetic resonance showed coal based oils had a higher aromaticity then those of petroleum, though both had a paraffin structure.

0106 Properties

REFER ALSO TO CITATION(S) 4293, 4295, 4296, 4297, 4298, 4300, 4301, 4304, 4305, 4308, 4310, 4311, 4312, 4317, 5080

4318 **(DOE/FE/60339—1) High sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, July 1-September 30, 1983.** (Southern Illinois Univ., Carbondale (USA). Coal Extraction and Utilization Research Center). 1983. Contract FC22-83FE60339. 28p. NTIS, PC A03/MF A01. Order Number DE84001789.

The overall objective of this research effort is to conduct a broad-based research program on high-sulfur coal and thereby expand the technology that will allow for the increased use of this coal in an environmentally acceptable manner. The Coal Technology Laboratory at Southern Illinois University at Carbondale has been established at the site of the former Carbondale Mining Technology Center. The research program is currently underway in four areas: coal science; coal preparation; coal conversion; and coal utilization. In order to facilitate the research, significant modifications must be made to the former CMTC facility. Plans for the modifications necessary to accommodate the research at CTL have been finalized. Work on the modifications will commence early next quarter. As a part of the overall research program, two major equipment items were to be acquired, a mass spectrometer and a fluidized bed combustion system. A request for bids was published for a high resolution gas chromatography mass spectrometer system. The bids have been received and evaluated. An order has been placed for a KRATOS MS-80 mass spectrometer system. Delivery of the system is anticipated to take place in April 1984. As KRATOS is not a domestic manufacturer, application will be made for duty-free entry of the instrument into the US. The acquisition of the fluidized bed combustion system has progressed to the stage where a request for bids has been published. Brief reports describe the progress made in the research projects during the first quarter.

4319 **(DOE/PC/40799—T7) Heteroatom speciation in coal liquefaction via FT-IR coupled with liquid chromatography. Quarterly progress report, July 1-September 30, 1983.** Taylor, L.T. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemistry). Dec 1983. Contract FG22-81PC40799. 28p. NTIS, PC A03/MF A01. Order Number DE84002177.

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We have chosen high performance liquid chromatography in the normal phase mode for analysis of azaarenes and aromatic amines in coal-derived products. Our mode of detection is on-line Fourier transform infrared spectrometry. This analytical method offers advantages over many GC/MS methods in that nonvolatile material may be handled, derivatization need not be performed prior to analysis and isomer identification is possible. The disadvantages due to sensitivity and mobile phase infrared transparency have been partly addressed by employing microbore columns and deuterated and/or halogenated chromatographic solvents. The use of low flow rates (μL/min) with microbore columns results in low solvent consumption which has advantages with respect to cost and disposal. Microbore columns provide an increase in eluent concentration over analytical scale columns for a similar amount of injected material. 19 references, 11 figures.

4320 **(DOE/PC/40809—18) Separation of asphaltenes using high resolution supercritical fluid chromatography. Final report, September 1981-August 1983.** Lee, M.L. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry). Nov 1983. Contract FG22-81PC40809. 91p. NTIS, PC A05/MF A01. Order Number DE84002934.

The objective of this project was to explore and more fully develop capillary supercritical fluid chromatography (SFC) as a high resolution separation technique. The developed SFC techniques were then to be applied to the separation and structural evaluation of various asphaltene fractions. This report covers the following work performed: (1) development of bonded stationary phases; (2) optimization of fluorescence detection; (3) ultraviolet absorption detection; (4) evaluation of different mobile phases; and (5) analysis of asphaltenes. 14 references, 40 figures, 9 tables.

4321 **(DOE/PC/60785—1) Organic oxygen characterization of coal and coal liquids. Quarterly progress report for August-October 1983.** Ehmann, W.D.; Hamrin, C.E. Jr.; Koppenaal, D.W. (Kentucky Univ., Lexington (USA)). Nov 1983. Contract FG22-83PC60785. 21p. NTIS, PC A02/MF A01. Order Number DE84003220.

Organically bound oxygen is one of the most abundant elements in coal, yet the amount and quality of data concerning its abudance, mode of occurrence, and processing behavior is relatively lean. The rectification of this problem will require the development of appropriate methods of oxygen determination, which have been lacking in the past. The stature of coal science today demands a technique for organic oxygen determination other than the outdated and error-prone oxygen-by-difference calculation. This investigation addresses this need and intends to develop methods suitable not only for total organic oxygen determination but also for determination of oxygen functionality. The methods and techniques developed will then be applied to practical needs in characterizing the oxygen geochemistry of coal and the evaluation of coal drying on liquefaction behavior.

4322 **(DOE/PC/60807—1) Supercritical fluid chromatography/supersonic jet spectroscopy. Progress report, August 1, 1983-October 31, 1983.** Lee, M.L.; Goates, S.R. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry). 1983. Contract FG22-83PC60807. 12p. NTIS, PC A02/MF A01. Order Number DE84002944.

A supercritical fluid fractionation apparatus was designed. Meanwhile, fractionation according to number of aromatic rings by gel permeation chromatography was evaluated. A vacuum still bottoms sample has been fractionated by this method. A high vacuum chamber and pumping system has been designed for supersonic jet spectroscopy. The chromatographic and sensitive detector systems are presently being assembled. 8 references, 3 figures.

4323 **(NERDDP-EG—80-16) The role of chemical reactivity of carbon in metallurgical applications.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

This article describes a project to provide a scientific basis for the best possible utilisation of Australia's coal resources, particularly in the metallurgical industries. The short term aims of the project are to determine the carbon dioxide reactivity of industrial brown coal chars which have been produced from coals of particular types and to examine the factors affecting reactivity. The long term objective would then be to determine the optimum reactivity for various industries.

4324 **(NERDDP-EG—81-20) Determination of trace elements in coal and coal products.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

The developed procedures enable the routine determination of up to 55 elements in raw coal and products using (X-ray) fluorescence spectrometry (XRF) and electrothermal atomization atomic absorption spectrophotometry (AAS). Typical detection limits are 1-2ug/g for XRF and 0.1-1ug/g for AAS. A computer program has been developed to simplify the data handling component of the XRF procedure.

4325 (NERDDP-EG—81-22) Colloid and surface chemistry of coal/oil/water systems. (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Considers the surface and interfacial effects and forces that influence the transfer of fine coal particles between water and oil. Such transfer forms an integral part of coal beneficiation and emulsion flotation and is intrinsic to coal-to-oil conversion processes. Three aspects of coal/oil/water systems are examined; coal evalution; model surfaces; and surfactants.

4326 (NERDDP-EG—82-37) Surface chemical treatment of fine coal with slime problems. (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

From the experimental work done it appears that the production of a slime coating on coal surfaces is dependent on the reduction or charge reversal of the negative clay surfaces due to preferential adsorption of hydrolyzed metal ion species onto these surfaces. Electrostatic interactions between at least the positive edge of the clay particles and negative coal surfaces result in slime adsorption. It is not possible to rule out the possibility of interactions involving the whole clay particle in the case of charge reversal of the face surfaces. Slime disposal and hence reactivation of the coal by phosphate additions appears to be dependent on reaction of ferric hydroxy species with phosphate species resulting in charge reversal of clay surfaces covered with ferric hydroxy species and charge reversal of positive edge surfaces.

4327 (NERDDP-EG—82-43) Flow properties and flow behaviour of coal in storage, pneumatic conveying, standpipe flows and fluidisation Australian coals. (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

The non fluidised flow properties of 4 Australian coals Tarong, Millmerran, Callide and Blackwater were measured in a Jenike flow factor tester. Each coal was tested at three different moisture levels, approximately 7%, 14% and 21% above inherent moisture. The tests were performed instantaneously as well as with a 48 hour time delay. As the flow function increases, the solid flows more easily.

4328 (NERDDP-EG—82-46) Reactive inertinite. (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

This article investigates the reactivity of the coal maceral group, inertinite, during carbonization. Inertinite is present in large quantities in many Australian coals, and it is thought to adversely affect coke stability. Coking tests were carried out on twenty coals of various rank at temperatures up to 1,000 C. Results from coked portions of the samples were correlated with those from relevant uncoked parts. Comparisons of optical properties of inertinite before and after carbonization suggest that bireflectance is a measure of reactivity.

4329 (NERDDP-EG—82-53) The characterization of coal by automated petrographic analysis. (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

This article describes the development of a rapid method for the quantitative petrographic analysis of coal. The method is based on reflectivity measurements so that in addition to the data on maceral distribution and vitrinite reflectance, as obtained by manual analysis, a complete reflectance distribution for the coal is obtained. The group maceral analysis results obtained are comparable to those produced by the standard manual methods. Difficulties were encountered in analysis of coals of low rank.

4330 (NERDDP-EG—82-65) Maturation studies in petroleum geochemistry. (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

This article describes a number of projects aimed at providing insight into the processes of thermal maturation of petroleum in petroleum source rocks. Fundamental aspects of the chemistry of the maturation process have been examined, and a simple technique using proton magnetic resonance spectroscopy has been developed. This technique has limitations when applied as a routine technique using hydrocarbons extracted from well cuttings; for example contamination problems resulting from drilling additives arise because of the difficulty of separating them from the in situ petroleum aromatics. Recent developments in liquid chromatography which allow a better defined and narrower polarity range of these complex aromatics to be isolated may overcome these problems and are being further examined in the laboratory.

4331 (TENRAC/EDF—094) Trace elements in Texas lignite. White, D.M.; Edwards, L.O.; DuBose, D.A. (Radian Corp., Austin, TX (USA)). 31 Aug 1983. 97p. NTIS, PC A05/MF A01. Order Number DE84900413.

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During coal mining and utilization, trace elements are released into the environment. Certain of these elements may have beneficial or neutral effects while other trace elements are potentially harmful. On a national basis, nine of these elements - antimony, arsenic, boron, cadmium, germanium, mercury, molybdenum, selenium, and silver - are commonly found in concentrations greater than the levels present in typical crustal rocks. Because of the conditions under which Gulf Coast lignites were deposited and the nature of lignites in general, the modes of occurrence and concentrations of trace elemetns in Texas lignites are different from coals found elsewhere in the United States. Based on a limited data set of 38 lignite samples from Arkansas, Mississippi, and Alabama compiled in 1975, Gulf Coast lignites were identified as having higher levels of boron lanthanum, lead, selenium, uranium, yttrium, and zirconium than other US coal regions. The objectives of this report are to: (1) discuss modes by which these elements occur in Texas lignites and the importance of depositional conditions; (2) tabulate the concentrations of various trace elements found in Texas lignites; (3) compare these concentrations on a regional basis with coals found in other parts of the US; and (4) assess the potential for release of these elements into the environment during lignite combustion. 24 references, 2 figures, 12 tables.

4332 (TENRAC/EDF—103) Characterization of mineral matter in East Texas lignites. Gueven, N.; Lee, L.J. (Texas Tech Univ., Lubbock (USA). Dept. of Geosciences). Aug 1983. 70p. NTIS, PC A05/MF A01. Order Number DE84900412.

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The purpose of this project is to characterize the mineral matter in Texas lignites and in their ashes. Low temperature ashing is a practical way to burn the coal in order to separate the mineral matter in the form of low temperature ash (LTA) without any serious alterations. Twenty-seven LTA samples have been selected from four lignite cores drilled in Shelby, Nacogdoches, Panola, and Rusk Counties in East Texas from the Sabine Uplift, Wilcox Group. The mineral matter in these LTA samples have been studied with x-ray diffraction (XRD) and with analytical electron microscopy (AEM). Quartz, bassanite, kaolinite and halloysite are the main mineral components in these lignites. Pyrite, illite, smectite, chlorite, barite, and feldspars generally occur in small quantities. The silica phase consists mostly of authigenic microquartz and of some detrital quartz. Following the determination of the mineral phases, we searched for the particles carrying hazardous elements such as As, Cd, Cr, Co, Pb, Hg, Mn, Mo, Ni, Se, V, Ag, Zn, Ti, U and Th. Particulate matter with high concentration of selenium and lead is found and it has been identified as a Pb-Se compound known as clausthalite. Similarly, particles with high Pb-Sn content are found in the form of spherules of about 300 A in size. Manganese is found in association with iron oxides occurring in the form of minute spherules of 200 A. A mineral particle with high Zr and Si concentration is identified as zircon. Titanium-rich particles con-

sist of needle-like crystals of rutile (or anatase) in the coal. 28 figures, 10 tables.

0108 Waste Management

4333 **(CONF-831155—2) Characterization of an industrial spray dryer at Argonne National Laboratory.** Farber, P.S.; Livengood, C.D. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 23p. NTIS, PC A02/MF A01. Order Number DE84003636.

From Symposium on flue gas desulfurization; New Orleans, LA, USA (1 Nov 1983).

Argonne National Laboratory (ANL) is operating an industrial-scale, coal-fired boiler with a flue gas cleaning (FGC) system consisting of a spray dryer and fabric filter. This paper presents a description of the FGC system together with a status report for an EPA-sponsored project being carried out by ANL to characterize the operation of the system. This project involves a design and economic analysis of the FGC system, determination of waste characteristics, and analysis of system operation through monitoring of inlet/outlet gas streams and sampling of various process streams. Preliminary data and material balances are presented in the paper, as well as a proposed performance model based on an analysis of key operating parameters.

4334 **(DOE/FC/10297—T8) Anaerobic treatment of gasifier effluents. Quarterly report, No. 9.** Cross, W.H.; Chian, E.S.K.; Pohland, F.G.; Saunders, F.M.; Giabbai, M.; Wang, E.; Whalen, K.; Lu, F.; Grubbs, T.; Havesh, J.; Gao, H. (Georgia Inst. of Tech., Atlanta (USA)). Sep 1983. Contract AC18-81FC10297. 8p. NTIS, PC A02/MF A01. Order Number DE84002641.

This report summarizes the work performed during the period from July 1, 1983 through September 30, 1983 on the DOE research program on Anaerobic Treatment of Gasifier Effluent. The major efforts have been directed toward: (1) the operation of two anaerobic systems treating about 10% strength raw wastewater with activated carbon replacement occurring in both systems; (2) the operation of a nitrifying system treating the anaerobic effluent; and (3) the operation of both packed bed and suspended growth denitrifying systems for treating the effluent from the nitrifying system. The progress of these efforts are depicted on the Gannt Chart along with project expenditures for the above contract and is presented in detail in this report. 2 figures.

4335 **(EPA—600/7-83-029) Economic evaluation of limestone and lime flue-gas-desulfurization processes.** Burnett, T.A.; Stephenson, C.D.; Sudhoff, F.A.; Veitch, J.D. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Div. of Energy Demonstrations and Technology). May 1983. 322p. (TVA/OP/EDT—82/6). NTIS, PC A14/MF A01. Order Number DE84900344.

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The preliminary-grade economics (accuracy: -15%, +30%) of various alternative limestone scrubbing options (absorber type, with and without forced oxidation, and with and without adipic acid enhancemet) are examined using the current design and economic premises established for the continuing series of economic evaluations performed by TVA for EPA. The economics are projected using the Shawnee lime/limestone computer model, which is based on long-term operating data from the EPA Alkali Scrubbing Test Facility at the TVA Shawnee Steam Plant near Paducah, Kentucky. The capital investment for the base-case limestone scrubbing process (500 MW, 3.5% sulfur coal, 1979 NSPS, spray tower, forced oxidation, landfill) is $206/kW. The first-year and levelized annual revenue requirements are 10.59 and 15.09 mills/kWh, respectively. Costs for the equivalent limestone scrubbing process using a Turbulent Contact Absorber (TCA) are lower while those for the venturi - spray tower absorber are higher. The forced-oxidation landfill disposal option has a lower capital investment than the unoxidized pond disposal option for all cases studied; however, the first-year and levelized annual revenue requirements are slightly higher for the forced-oxidation landfill process for most coal applications. For the spray tower limestone process to achieve a specified SO_2 removal efficiency, it is more economical to increase the limestone stoichiometry and minimize the absorber L/G. The use of adipic acid or possibly dibasic acid (DBA) as an additive to enhance SO_2 removal in the limestone scrubbing process is an economically attractive option. The use of adipic acid remains economically attractive even if both a high unit cost and a high degradation factor for adipic acid are assumed. 176 references, 35 figures, 56 tables.

0109 Environmental Aspects

REFER ALSO TO CITATION(S) 4286, 4303, 4307, 4840

4336 **(LA—9747-PR) Radioactive emissions from coal production and utilization: the typical case put into perspective. Final progress report, June 30-September 30, 1982.** Greiner, N.R.; Wagner, P. (Los Alamos National Lab., NM (USA)). Aug 1983. Contract W-7405-ENG-36. 8p. NTIS, PC A02/MF A01. Order Number DE84003560.

Radiochemical analyses of the uranium-series nuclides were done on coals and waste products from 21 coal-fired power plants. Leachability and radon-222 emanation measurements were made on the solids. The radioactivity found and reported in this series of reports was very near the literature values for radioactivity in soil, water, and air. The radioactivity added to the air by fly ash from a 1000-MW power plant with 99.0% controls is very small compared with the radioactivity already present on natural airborne dust. Consequently, the radiologic effects and concomitant health and environmental effects from coal-fired power production appear to be quite minute in the typical case. Future research should focus on the effects of atypical situations. We have developed a way to lend perspective to the effects of small doses of trace elements (such as radionuclides) added to the environment by industrial activities. Preliminary results of a study of the effect of moisture on ^{222}Rn emanation by coals are reported.

4337 **(N—8326186) Computer-aided siting of coal conversion facilities.** Moreno, D.D. (Dames and Moore, Los Angeles, CA (USA)). 1982. 15p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 432-446 (SEE N83-26176 15-43).

The value of using geographic information systems in site selection for coal conversion plants is discussed. Environmental and cultural factors and capital/operating costs were considered to determine site suitability.

0110 Reserves And Exploration

4338 **(NERDDP-EG—80-11) Minimum economic reservoir size.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

The minimum Economic Reservoir Size (MERS) Project was established to estimate the smallest undiscovered oil or gas reservoir that could be developed economically. Seven areas of Australia were studied, and the physical characteristics of undiscovered reservoirs were estimated. A computer program was used to determine the most likely system for the production and transport of hydrocarbons, and the timing and magnitude of the costs involved for each case. The MERS program uses current Federal and State royalty and taxes, variables include: well yields, production build-up, maximum production rates, decline rates, and capital and operating costs. The results of changing the variables are shown both on a year by year forecast and as a cash flow rate of return.

0120 Mining

REFER ALSO TO CITATION(S) 4837, 4840

4339 **(CSIRO-DAG-GCM—25) Program WEDBERG: a slope stability wedge analysis.** (Commonwealth Scientific and Industrial Research Organization, East Melbourne (Australia)). 1983. vp. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

The relevance of the two wedge stability analysis to field situations is discussed. A method for stability analysis based on virtual work is presented and compared with similar limiting equilibrium methods. The development and stability analysis is given in detail, including source code in Fortran IV and worked samples.

4340 **(CSIRO-DAG-GCM—40) An example of the use of a borehole penetrometer to investigate the caveability of a roof sequence.** (Commonwealth Scientific and Industrial Research Organization, East Melbourne (Australia)). 1982. vp. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

This paper describes the use of a small diameter borehole penetrometer designed for operation in roof bolt holes, to determine the profile of in situ strength of the roof above development headings of the Ellalong Colliery holding of Newcastle Wallsend Company. The information obtained was used, in conjunction with other data, to predict the likely operating requirements for hydraulic supports to be employed in a longwall extraction operation in the area concerned.

4341 **(CSIRO-DAG-GCM—43) Sliding and toppling failures in an open strip mine highwall.** (Commonwealth Scientific and Industrial Research Organization, East Melbourne (Australia)). 1983. vp. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

A number of electronic deformation measuring instruments were installed in boreholes to register the possible development of highwall instability in an open strip coal mine. The slope failure was much shallower than expected and did not affect the instruments. Site observations revealed that a combination of sliding and toppling failures was occurring, with the lower boundary of the failed region being the Tertiary Permian unconformity which was moist and dipping into the pit at between 9 and 15 degrees. The mechanism of slope failure which had more effect on the mining operations was block sliding. Toppling failure appeared to be caused by differential settlement of the Tertiary material on the top of the Permian material. Slope stability analyses and recommendations for improving slope stability are made.

4342 **(CSIRO-DAG-GCM—44) Preliminary laboratory investigations of the reconsolidation characteristics of overburden above the Goonyella Middle Seam, Goonyella, Queensland.** (Commonwealth Scientific and Industrial Research Organization, East Melbourne (Australia)). 1983. vp. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

The results of an initial series of small scale laboratory consolidation tests conducted on the overburden material overlying the Goonyella Middle Seam are described. The influences of initial moisture content, consolidation load and consolidation period on bending strength of the reconsolidated product are discussed. Simplified analyses predicting the likely effectiveness of the reconsolidation material as a possible sequential roof for multi slice extraction of the Goonyella Middle Seam are presented.

4343 **(NERDDP-EG—81-28) Gas drainage and outburst investigations.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Attempts to design a successful gas drainage system in the working at West Cliff Colliery are described. The effects of gas drainage in outburst prone areas are investigated. The efficiency of a predrainage system and its effects on gas emission rates during subsequent mining operations are examined. A system for post drainage of gas from adjacent seams subsequent to mining operations being completed is assessed.

4344 **(NERDDP-EG—82-55) Spoil pile stability.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. 41p. National Energy Research Development and Demonstration Council, Canberra, Australia.

Presents the results of detailed investigations into the stability of the spoil pile at Burwood Colliery. The physical properties and behaviour of dump material have been studied. Stability calculations have been made. The dump is porous and free draining, it is considered stable, although there is some softening of the clay at the base of the dump where water seepage occurs.

4345 **(TENRAC/EDF—114) Hydrologic site selection for mining of deep basin lignite in Texas. Final report.** Charbeneau, R.J.; Wright, S.G. (Texas Univ., Austin (USA). Dept. of Civil Engineering). Aug 1982. 123p. NTIS, PC A06/MF A01. Order Number DE84900410.

Population and industrial growth within the state of Texas during the remainder of this century and into the 21st century will result in a significant increase in the demand for energy. Because of the depletion of the state's oil and gas reserves for use in energy production and because of the universal scrubbing requirements which have removed the primary advantage of low-sulfur western coal, it is expected that Texas lignite will be the fuel preferred by many of the state's utilities and industries. Near surface lignite reserves are adequate to meet the needs of the early decades of the 21st century. Meeting the demands of the decades beyond will require the recovery of deep basin lignite or a transition to alternative energy fuels. The subject of this research is the hydrological and geomechanical feasibility and impact of open pit mining and underground coal gasification for recovery of deep basin Texas lignite. Of major concern are the quantities and uses of water from site dewatering and depressurizing operations, the stability of open pit mine slopes and how it is influenced by water, and the regional hydrologic impacts of lignite mining. A summary of the conclusions from this research follows. Water use from open pit mine dewatering and depressurizing operations is significant, though the amounts are very much site specific and dependent on the mine plan. The major variables which influence the total system discharge are the geometry of the mine cut, the required drawdown and dewatering time, aquifer hydraulic and storage parameters, and local stratigraphy. Mathematical models are presented which quantitatively show how these variables influence the water quantities. In general, the quantities of water associated with dewatering can greatly exceed those associated with depressurization of an underlying aquifer.

0130 Transport And Handling

REFER ALSO TO CITATION(S) 4291, 4318, 4327

4346 **(NERDDP-EG—80-7) Stockpiling procedures investigations.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

The project was an investigation into various stockpiling methods that might be used to prevent deterioration of coking coal qualities when stockpiling Bulli seam coal. It was originally assessed that oxidation of the coal was the problem to be investigated and accordingly it was decided to monitor fluidity as the parameter most likely to reflect oxidation. The stockpile created contained over 400,000 tonnes of coal.

4347 **(NERDDP-EG—80-15) Energy transport: a case study for the electricity supply industry.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Compares the cost of transporting energy to supply a 2,000 megawatt electrical load in a city from coalfields approximately 88, 600, 350 and 130 km away by means of a EHV transmission, unit trains (diesel and electric) on a new railway, a coal slurry pipeline, a gas pipeline and a coal derived liquid pipeline: It is assumed that the clean gaseous or liquid fuels derived from coal are available for an advanced gas turbine steam turbine combined cycle generating station.

4348 **(NERDDP-EG—82-52) Wet classification of fine coal with particular reference to flotation feeds.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1982. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Assesses the performance of various pieces of commercially available equipment for wet classifying fine coal (minus 0.5 mm) into a coarse fines fraction (minus 0.5 mm, plus 0.1 mm) and an ultrafine fraction (minus 0.1 mm). The equipment selected for evalution was a 225 mm Linatrex hydrocyclone, a 0.70 m2 DSM rapped sieve bend and a 0.33 m2 Derrick screen. The results obtained show that the partition curve and water split to oversize is dependent on the solids flow rate. The undersize efficiency was susceptible to solids flow rate, and it was less than 70% for solids flow rates greater than 10 tonnes per hour.

0140 Combustion

REFER ALSO TO CITATION(S) 4309

4349 **(DOE/PC/30213—T4) Coal combustion in high convective flows. Final report, September 1, 1980-August 31, 1982.** Ragland, K.W. (Wisconsin Univ., Madison (USA). Dept. of Mechanical Engineering). Dec 1982. Contract FG22-80PC30213. 45p. NTIS, PC A03/MF A01. Order Number DE84001029.

Fundamental data on the combustion of captive millimeter size coal particles in a laboratory furnace has been obtained at temperatures of 800 to 1200°K, Reynolds numbers of 60 to 600, oxygen concentration of 0 to 21%, and particle sizes of 4.6 to 10.1 mm for a low-swelling bituminous, a swelling bituminous, a sub-bituminous and a lignite coal. Particle mass was measured continuously during the burn and particle reactivity versus time was calculated from the mass time curves. Particle size was determined from photographs. Carbon dioxide and carbon monoxide concentrations were used to determine volatile burn and char burn times. Particle reactivity was influenced by heat transfer and oxygen mass transfer, and to a lesser extent by coal rank. Char reactivity is diffusion controlled above 1000 K. Maximum reactivity during volatile burn was 12 to 47 mg/s-g for the conditions tested. Char reactivities decreased through the burn and typically averaged 5 to 10 times less than peak volatile reactivities. The porosity of the char ranged from 70 to 95%. Total burn time follows a square law relationship with initial diameter, varies linearly with oxygen concentration, and also depends on Reynolds number and temperature. Total burn times ranged from 86 to 573 s. Char burn was 2 to 7 times longer than volatile burn.

4350 **(NERDDP-EG—80-12) Ignition in a pulverized brown coal furnace.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

This paper describes a mathematical model which has been formulated to describe the behaviour of a cloud of brown coal particles in a burner environment. The model has been used to compute particle temperature, volatile release and char burnout along the centre line of the discharge from a power station burner, in which gas temperatures and compositions were known from measurements. In the development of the model, it was shown that entrainment of hot combustion gas is the dominant mechanism for heating the coal particles to the temperature necessary for devolatilisation and combustion to occur.

4351 **(NERDDP-EG—80-14) A survey of the National requirements for research, development and demonstration into fluidized bed combustion.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

The report presents guidelines for research, development and demonstration in Australia of the direct combustion technique known as fluidised bed combustion. These guidelines are primarily aimed at the wider use of Australian coal reserves. The priorities set are based on an assessment of the immediate and longer term energy need for coal, the priorities established by NERDDC, the results of a comprehensive survey of interested groups in Australia and a review of overseas developments. The priorities recommended are 1. the demonstration of a coal fired fluidised bed combustion packaged boiler, 2. pilot plant studies leading to the demonstration of power generation by fluidised bed combustion especially for applications involving troublesome coals and coal wastes, 3. fundamental studies aimed at developing process understanding and plant improvements 4. the development of a small to medium scale fluidised bed gas producer and 5. the development of fluidised bed combustors for the utilisation of industrial, municipal and agricultural wastes and low grade fuels.

4352 (PNL-SA—11552, pp 145-159) **Small scale combustion testing of synthetic-fuels.** Gibbon, G.A.; Ekmann, J.M.; White, C.M.; Navadauskas, R.J.; Retcofsky, H.L.; Joubert, J.I. (Pittsburgh Energy Technology Center, PA). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Although complete analyses of all the combustion tests are not available, the results are encouraging. All fuels tested appear to perform like No. 2 and No. 6 fuel oil. No difference in rated capacity occurs between fuels. Particulate, CO, and hydrocarbon emissions are low, as one would expect from low ash fuels, which atomize and burn regularly. No significant difference in soot formation or tendency to smoke was noticed between fuels. Typical qualitative analytical results of the combustion products for two successful burns appear in Table 10. The compounds were identified on the basis of both mass spectral and gas chromatographic data. These analytical results were obtained on samples collected during the combustion of SRC-II and No. 2 fuel oil. The fuels were combusted under very similar conditions and the samples were collected under identical conditions. Therefore, a comparison of the data derived from these combustion experiments appears to be valid and begins to answer the questions of what differences and similarities there are in the organics vapors present in the exhaust duct when a synfuel and petroleum product are combusted. The collected samples have been initially characterized for polynuclear aromatic hydrocarbons. The results indicate that there is a wider spectrum of polynuclear aromatic hydrocarbons present when SRC-II is combusted than is present when No. 2 fuel oil is combusted. In both combustion experiments, the organics in the duct appear to be similar to those in the fuel being combusted. The vapors collected appear to represent a mix of uncombusted fuel plus combustion products. It is interesting to note that no flameouts occurred during these combustion experiments. Apparently even during good combustion conditions, some liquid fuel survives the combustion process and appears in the duct.

0150 Marketing And Economics

REFER ALSO TO CITATION(S) 4347, 4629

4353 **(EAS-H—3-82) The future economics of coal-based energy in the residential market.** (International Energy Agency Coal Research, London (UK)). Feb 1983. 189p. IEA Coal Research, London, England.

The future residential markets for coal-based energy are identified, and the costs of residential heating are examined with reference to SNG, electricity, district heating, and the direct use of coal. Four case studies are presented and discussed: Sweden, United Kingdom, United States winter-peaking electricity generating systems, United States summer- peaking electricity generating systems. The impact of technological development is considered, and the possibility of the economic substitution of oil or natural gas by some form of coal-based energy is assessed.

4354 **(ECE/COAL—74) The coal situation in the ECE region in 1981 and its prospects.** (United Nations, New York (USA)). 1983. 108p. United Nations, New York, NY.

Divided into two parts: the first discusses the coal situation in general, examining demand production, consumption and trade;

the second deals with each country in turn assessing demand, supply, international trade, and long-term trends in coal supply and demand.

4355 **(GAO/RCED—83-210) Economics of the Great Plains coal gasification project.** (General Accounting Office, Washington, DC (USA). Office of the Comptroller General). 24 Aug 1983. 34p. General Accounting Office, Document Handling and Information Service Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to The Chairman, Subcommittee on Environment, Energy, and Natural Resources, Committee on Government Operations House of Representatives.

the Great Plains project will be the Nation's first commercial-scale plant producing synthetic gas from coal. The project's first annual economic report, released in March 1983, was much less optimistic than a similar analysis prepared in January 1982 to justify construction. GAO found that: the main reason for the changed economic outlook was that the assumed synthetic gas prices used in the March analysis were significantly lower than those used previously. Great Plains did not, nor was it required to, consider tax implications to the parent companies of the project's partners. If these implications are considered, the economics could be more optimistic than the March 1983 report indicates. Should the partners end their participation, some tax benefits would have to be repaid. Although the project is a potentially attractive investment, its financial viability is extremely sensitive to the future prices of synthetic gas. Even a small deviation in prices could significantly affect its economics.

4356 **(IEA/EAS—E2/80) Economics of gas from coal.** Teper, M.; Hemming, D.F.; Ulrich, W.C. (IEA Coal Research, London (UK). Economic Assessment Service). Jan 1983. 138p. NTIS (US Sales Only), PC A07/MF A01. Order Number DE84900293.

This report, part of the Economic Assessment Service (EAS) work program on the economics of coal technology, is a study of coal gasification economics. It deals with these questions: what does gas from coal cost and what affects this cost; how do different approaches and processes compare; and how near to competitive cost-levels is present-day technology. Discussion covers production of both substitute natural gas (SNG) and medium calorific gas (MCG: 10 to 16 MJ/Nm^3 or 250 to 400 Btu/SCF). SNG processes covered are: BCR BI-GAS, British Gas/Lurgi, Exxon Catalytic, IGT HYGAS, Lurgi, Shell Coal, and Texaco. Conclusions are that SNG from low-cost US coal and west German brown coal are, on the basis of mature technology and government rates-of-return, roughly competitive with gas imports into the US and Europe, respectively. Similarly, MCG from second-generation gasifiers is competitive with gas-oil or No. 2 heating oil in Europe, North America and Japan. However, capital costs form about half total gas costs at 10% rate-of-return, so that the competitiveness of gas from coal is sensitive to capital costs: this is the area of greatest uncertainty. 112 references, 15 figures, 22 tables.

0160 Health And Safety

REFER ALSO TO CITATION(S) 5428

02 PETROLEUM

0201 Reserves

4357 **(GAO/RCED—83-203) Status of Strategic Petroleum Reserve activities as of June 30, 1983.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 13 Jul 1983. 28p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

The Department of Energy reported that the Strategic Petroleum Reserve contained 332.5 million barrels of oil on June 30, 1983. During the third quarter of fiscal year 1983, 20.7 million barrels of oil were added for a fill rate of 227,000 barrels per day. This report discusses a number of significant events which occurred during the quarter and which affected the Reserve. It also discusses the progress being made in filling, developing, and operating the Reserve.

0202 Geology And Exploration

REFER ALSO TO CITATION(S) 4375, 4420

4358 **Semiautomated method for cation-exchange capacity determination of reservoir rocks.** Gall, B.L.; Raible, C.J.; Volk, L.J. (U.S. DOE). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* **23**: No. 2, 231-237(Apr 1983).

The presence of significant amounts of clay in tight-gas sand formations makes the determination of cation exchange capacities (CEC) important for electric-log, self potential (SP), and gamma ray log interpretation. In the past, CEC measurements have been difficult and time-consuming to obtain. However, an automated method that avoids many difficulties of other techniques while determining the CEC's of many samples at one time has been described by Worthington. This work is a modification of the work done by Worthington. Easily assembled commercial equipment instead of specially built equipment is used to agitate rock samples contained in dialysis membrane bags during ion exchange with barium acetate solution and during washing of the samples to remove excess barium ions. Barium acetate is used as the source of barium ions instead of barium chloride, which is used in Worthington's procedure, to avoid corrosion of the stainless steel equipment. The amount of barium ions on the rock samples is then determined by conductometric titration with magnesium sulfate. The titration procedure is not automated. In addition, the use of the barium ion method was extended to samples with CEC values an order of magnitude lower than those determined by Worthington.

4359 **Future of gas and oil from the sea.** Mangone, G.J. (ed.). New York, NY; Van Nostrand Reinhold Company (1983). 235p. (DOE/RA/50574—T1). Van Nostrand Reinhold Co., 135 W. 50th St., New York, NY 10020. Contract FG01-81RA50574.

From the text it will be seen that as much gas and oil remains to be found under the world ocean as already has been found under dry land. The challenge to drill and recover hydrocarbon resources from frontier areas, under deep water rolled by high winds or in frigid Arctic areas, has been described by the authors with illustrations of the advancing technology in drilling rigs and their equipment, new types of tankers and vessel transfers, and improved pipeline transmission of gas and oil. Moreover, the human factor of training and safety, critical to the efficient use of modern technology, have been explored. The book also examines the effect of regulation of the offshore industry by the government through the Outer Continental Shelf Act and its administration as well as the problems of ascertaining the environmental effects of the recovery of gas and oil from the seabed. The 10 chapters in this book, each written by different authors, are: (1) petroleum from the oceans: resources, exploration and world energy role; (2) oil and gas resources of the US Continental margin; (3) deepwater drilling and production systems for the 1980s; (4) Arctic drilling and production systems; (5) pipeline for offshore gas and oil; (6) buoy loading of tankers in offshore oil fields; (7) safety standards and accidents in frontier drilling operations; (8) workplace safety problems in offshore operations; (9) US geological survey regulatory program for the Outer Continental Shelf; and (10) environmental effects of offshore drilling.

4360 **Flexichoc implosion source: a system for offshore seismic prospection by means of extended source arrays.** Cholet, J.; Grau, G.; Magneville, P.; Rialan, J. (Institut Francais Du Petrole, L'Etang-La-Ville, France). pp 805-834 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The advantages of spread firing points, which are well known for onshore seismics, are becoming to be appreciated for certain applications in marine seismics. A method is described for constructing extended source arrays enabling pure and repetitive signals to be obtained. The basic source is the Flexichoc 506. The arrays are made up by bringing together a suitable number of elements carrying the sources and towing them in the desired position and at the desired depth. An array of 16 Flexichoc 506's has been tested. The first results show that considerable penetrations can be achieved without unduly sacrificing the resolving power. 8 references, 16 figures.

4361 **Monitoring the position adopted by seismic arrays during prospection.** Delignieres, R.M. (Institut Francais du Petrole, Rueil-Malmaison). pp 835-861 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

A telemetering system for monitoring the distance between three parallel streamers has been designed and developed. The distances are obtained by measuring the travel time of acoustic waves between six ultrasonic transmitters set out along the length of the central streamer, and six pairs of receivers located opposite them in the side streamers. These distance measurements do not disturb the seismic signals received. 15 figures.

4362 **Research on geophysical methods and techniques for complex geological situations.** Muzzin, A.; Cassano, E.; Savelli, S. (AGIP S.p.A., Milan, Italy). pp 862-889 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Experimental seismic surveys have been carried out in some areas of the southern Appennines, with the aim of defining new and more effective acquisition techniques, by modifying and improving the commonly used technologies and methodologies, to obtain useful and interpretable information in areas of very poor seismic response. The seismic sections obtained were generally of inferior quality, with fragmental and incoherent data, which however, are thought to reflect the complexity of the tectonic situation of the surveyed subsurface, complicated by the heterogeneity of the shallow and deep formations. The prospection for hydrocarbon reservoirs in these areas is very difficult owing to the severe phenomena of allochtony and overthrusting. To minimize the dispersions of the seismic wave fronts, microspread configurations were used in conjunction with different energy sources. Also tridimensional surveys have been carried out. The results obtained are not always positive. Each area has its own peculiar problems which cannot be tackled univocally. Particular efforts have been placed in digital data processing. Existing programs have been implemented and modified to adapt them to the quality of the available seismic data. Encouraging results have been achieved, but so far, it has not been possible to single out a technology which could always be applied, with success, in areas of highly complex geology. In the field of the non-seismic methods experimental processing has been performed to reduce the Bouguer anomalies to a single horizontal plane. Furthermore a microgravimetric survey has been carried out to verify the possibility of identifying lateral facies variations connected with seismic reflectivity anomalies (bright spots). The results obtained in this field are satisfactory, even if they cannot be considered conclusive. 16 figures.

4363 **Use of crosswaves for seismic prospection.** Garotta, R. (Compagnie Generale de Geophysique, Massy, France). pp 890-906 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The first experiments on crosswaves concerned explosive or mechanical sources specific to the transmission of SH waves. The results obtained from explosive charges, from the MARTHOR horizontal impacting device and from the horizontal vibrator are compared on an experimental profile. The outcome of this is that today SH waves can be produced industrially from any of these sources, all of which are qualitatively equivalent, the selection depending on practical considerations. The results obtained from crosswaves are sometimes superior or inferior to those of pressure waves. However, it is the comparison and combination of results according to the P and S modes that shows the greatest promise. On sites already investigated, the variations of the Poisson coefficient within intervals lying between associated P and S horizons have been studied. A path towards improvement can already be plotted, consisting in seeking to correlate increasingly narrow intervals. In this field, where verifications and calibrations of seismic data on wells transpire necessary, the vertical seismic profile would appear to be a highly useful intermediary. 2 figures.

4364 **Pre-site surveys for geophysical measurements in ice covered waters.** Edelmann, H.A.K. pp 907-912 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

In the future special geophysical research vessels will be used even more for hydrocarbon prospecting in arctic and antarctic areas. These ships have to be able to operate for longer periods without endangering the ship and crew in ice covered sea. To perform this, the ship needs a detailed and reliable prediction about the possibility of navigation in the area to be explored. Experience shows that satellite pictures, ice reports and ship's radar, as used for commercial routing, are not sufficiently accurate and reliable. A helicopter pre-site survey method will therefore be developed to have an autonomous and task oriented system available.

4365 **Integrated navigation system for prospecting for hydrocarbon deposits in the continental shelf.** Wassel, M.W.; Luebke, H. (PRAKLA-SEISMOS GmbH, Hanover, Germany). pp 913-930 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

First of all, an overall view is given of integrated navigation as applied to prospecting in continental shelf areas. Next, the degrees of accuracy required for geophysical exploration are explained. On this basis an explanation is then given of the need for a further development of navigation for the continental shelf area, including a review of the errors and limitations of available navigation sensors. The main results of theoretical studies are described. In particular, new methods of satellite navigation and integration are discussed and illustrated by means of examples - thus making a comparison with earlier methods possible. 5 references, 8 figures.

0203 Drilling And Production

REFER ALSO TO CITATION(S) 4359, 4398, 5113, 5159, 5160

4366 **(DOE/BETC—83/3) Contracts for field projects and supporting research on enhanced oil recovery and improved drilling technology. Progress review No. 35, quarter ending June 30, 1983.** Linville, B. (ed.). (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Oct 1983. 78p. NTIS, PC A05/MF A01. Order Number DE84003596.

Progress reports are presented for field projects and supporting research for the following: chemical flooding; carbon dioxide injection; thermal/heavy oil; resource assessment technology; extraction technology; environmental and safety; microbial enhanced oil recovery; improved drilling technology; and general supporting research.

4367 **(DOE/BETC/RI—83/9) Technical constraints limiting application of enhanced oil recovery techniques to petroleum production in the United States.** (USDOE Bartlesville Energy Technology Center, OK). Jan 1984. 60p. NTIS, PC A04/MF A01. Order Number DE84003910.

In the interval since the publication in September 1980 of the technical constraints that inhibit the application of enhanced oil recovery techniques in the United States, there has been a large number of successful field trials of enhanced oil recovery (EOR) techniques. The Department of Energy has shared the costs of 28 field demonstrations of EOR with industry, and the results have been made available to the public through DOE documents, symposiums and the technical literature. This report reexamines the constraints listed in 1980, evaluates the state-of-the-art and outlines the areas where more research is needed. Comparison of the 1980 constraints with the present state-of-the-art indicates that most of the constraints have remained the same; however, the constraints have become more specific. 26 references, 6 tables.

4368 **Volumetric requirements for foam and mist drilling operations.** Okpobiri, G.A.; Ikoku, C.U. (University of Tulsa). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* No. SPE 11723, 531-548(Mar 1983). (CONF-830312—). Contract AC19-79BC10079.

The present state of the art in foam and mist drilling suggests a need for predictive models for volumetric requirements that properly account for frictional losses due to the solid phase in solidsfoam slurry flow, settling velocities of such solids, and pressure drop across bit nozzles during foam flow. The objective of this paper is to fulfill this need. A model for predicting pressure drop across bit nozzles for foam and mist is presented. It accounts for the compressibility of foam, but assumes negligible pressure losses due to friction and change in elevation. A model has been developed for predicting minimum volumetric requirements for foam and mist drilling operations. It accounts for the frictional losses due to the solid phase, pressure drop across bit nozzles, and particle settling velocity. The technique offers a high degree of flexibility in the selection of wellhead injection pressures and volumetric injection rates. Field application of this work can be accomplished by two methods depending on compressor specifications. These are the "variable back pressure" and "constant back pressure" schedules. These are primarily graphical. Charts are presented for 7.875 and 9.00-inch hole sizes, and cuttings sizes of 0.500, 0.75, and 1.00 inch. Penetration rates range from 30 to 90 ft/hr.

4369 **A new model for well test data analysis for naturally fractured reservoirs.** Lai, C.H.; Bodvarsson, G.S.; Tsang, C.F.; Witherspoon, P.A. (Lawrence Berkeley Laboratory). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* No. SPE 11688, 213-226(Mar 1983). (CONF-830312—). Contract AC03-76SF00098.

A new model for the analysis of constant rate well test data from naturally fractured reservoirs is presented. The model considers three sets of orthogonal fractures with fluid flow from the fractures to the well and from the rock matrix to the fractures. In comparison to other models for naturally fractured reservoirs the present model allows fully transient fluid flow from the rock matrix to the fractures and a cubic geometry of the matrix blocks. The model has been used to develop type curves for the analysis of drawdown and build-up tests as well as pressure transient data from observation wells. The reservoir systems considered include an infinite and a finite (no-flow outer boundary) system and a system with a constant pressure outer boundary. The effects of wellbore storage and skin are illustrated. The model is applied to field data to illustrate the method of analysis and the applicability of the model.

4370 **Limitations on the oil-steam ratio for truly viscous crudes.** Doscher, T.M.; Ghassemi, F. (Doschers Group Inc.). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* No. SPE 11681, 151-154(Mar 1983). (CONF-830312—). Contract AT03-76ET12075.

Scaled physical model studies have yielded results which suggest that very viscous crude oils having a viscosity somewhat greater than that of San Joaquin Valley crudes cannot be economically recovered by an unassisted steam drive.

4371 **Enhanced oil recovery data base analysis by simplified predictive models.** Ray, R.M.; Wesson, T.C. (U.S. DOE-BETC). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* No. SPE 11259, 63-74(Nov 1982). (CONF-8211117—).

The U.S. Department of Energy, Bartlesville Energy Technology Center (BETC), has been developing computerized data bases and simplified predictive models to be used to predict enhanced oil recovery (EOR) potential in the U.S. The development phase of this work is nearing completion whereupon the models and data bases will be made available to the public. This paper describes the overall development phase for the models and data bases with analyses of selected EOR projects using the predictive models. Examples of model outputs are discussed and brief descriptions of the predictive algorithms are given.

4372 **Simplified economic screening models for enhanced oil recovery processes.** Paul, G.W.; Ford, M. (Intercomp, Houston, TX). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 988-993(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

The effective screening of reservoirs for implementation of enhanced oil recovery processes is critical to the financial success of a proposed project. Screening techniques that have been used in the past normally consisted of comparing individual reservoir and fluid properties with tables of the preferred values of these properties. The shortcoming of this procedure is that it does not account for interactions among the technical parameters, nor does it provide a measure of the economic attractiveness of the project. Intercomp has developed, under the sponsorship of the Bartlesville Energy Technology Center of DOE, a set of economic screening models for micellar-polymer, steam drive and CO_2 miscible EOR processes. These models include accurate oil production predictive algorithms and routines which provide measures of economic attractiveness based on time value of money economics. The formulation of these models is presented with examples of their use.

4373 **The potential of petroleum microbiology.** Donaldson, E.C. (Bartlesville Energy Technology Center, U.S. Department of Energy, Bartlesville, Oklahoma). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: vp(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

Microbes of various types, aerobic, anaerobic, mesophilic, and the thermophilic, produce a large number of chemical compounds as products of their metabolism. The type of product and quantitative yield depends on the specific microbial colony, nutrients provided for its growth, and prevailing environmental conditions. Within the range of products are the gases carbon dioxide, hydrogen, and methane, polymers which are either polysaccharides or proteins, surface active compounds that are generally poly-anionic lipids, low molecular weight solvents such as alcohols and ketones, and low molecular weight carboxylic acids. Laboratory experiments have shown that some of the metabolites are capable of releasing oil from packed sand columns and rocks, some cultures can reduce the viscosity of heavy oils by as much as 95 percent, and the polymers are useful for plugging high permeability zones and displacing oil through mobility control. Precisely controlled pilot experiments under joint supervision of microbiologists and engineers are necessary to scale the processes to field quantities for development of this potentially new technology.

4374 **Enhanced oil recovery: a look at its technical and economic viability.** Kuuskraa, V.A.; Stosur, G. (Lewin and Associates Inc., Washington, DC). *Energy Technology (Washington, D.C.);* **9**: 777-792(Jun 1982). (CONF-820217—).

From 9. energy technology conference; Washington, DC, USA (16 Feb 1982).

Enhanced oil recovery (EOR) technologies introduce fluidized materials into the reservoir to mobilize and produce additional oil. Thermal methods, gas flooding, chemical flooding, and novel technologies are listed. This paper examines the economic viability of EOR, current incentives and disincentives, and relative economics of the various processes. Geologic data, process performance projection costs, and consideration of special factors are needed to estimate costs.

4375 **New technologies for exploration and exploitation of oil and gas resources. Volume 2.** London, England; Graham and Trotman Limited (1979). 612p. (CONF-7904180—Vol.2). Graham and Trotman Limited, Bond St. House, 14 Clifford St., London, England W1X 1RD.

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Volume II contains 26 technical papers covering the following topics: geophysics; drilling; offshore platforms; production operations; pipelines; enhanced recovery; natural gas; submersibles/diving; and safety. All of these papers have been abstracted and indexed for the Energy Data Base. (ATT)

4376 **Possibility of using titanium for extending the riser in great depths of water.** Guesnon, J. (French Petroleum Inst., Rueil-Malmaison); Pierrat, O.; Renard, B. pp 931-951 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The limit in terms of depth of water of offshore drilling currently lies at about 1800 metres owing to the capabilities of the floating supports now in service. There are two main reasons for this limitation, directly related to the riser, namely: the limits of use of the riser tensioning system, which is at present at the maximum of its possibilities, and the impossibility of fully storing the riser aboard the support in view of the considerable space taken up by the buoyancy tanks. To summarize, it is mainly a problem of weight and space, since the buoyancy tanks designed to solve the problem of weight aggravate the problem of space. One solution to these problems would be to reduce the weight of metal of the riser. In this context, replacing the steel by titanium, which has almost half the density, would appear attractive. Titanium, in fact, offers very high mechanical properties in view of its density, while also offering excellent corrosion strength. It is therefore the ideal metal for use in a marine environment. For this reason, the objectives of the present study are: determination of the technical and economic interest of such a solution, the conception and subsequently the design of riser components best suited to the requirements resulting at one and the same time from drilling in great depths of water and the use of titanium, and following construction and the testing of prototypes, selection of the manufacturing methods that appear the most appropriate for each of these components. 7 figures.

4377 **Experience and results obtained with the PELERIN and PELICAN in deep or hostile seas.** Marce, R.P.; Fort, G. (CFP/Total, Boulogne-Billancourt, France). pp 952-977 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The need to discover new energy resources and reserves no longer has to be proved - it is a question of stark survival. Today, petroleum is one of these fundamental sources of energy and considerable reserves are thought to exist offshore in deep waters. The ambitious and costly undertaking of proving this and harnessing these reserves was started in 1967. After a cursory summary of the origins, tests, experience and results, it is hoped to convince the reader that in the field of petroleum exploration in deep or hostile seas, the drill ship, PELERIN is the equivalent of what SKYLAB and SOYUZ are in the field of space or solar research.

4378 **Development of Seafox Tethered Buoyant Platforms.** Lonergan, J. (Freeman Fox and Partners, London, England). pp 979-994 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Seafox Tethered Buoyant Platforms have been designed for use as oil production platforms in deeper waters. The initial concept of a submerged buoyant chamber tethered to the seabed by triangulated tensioned cables has been developed and modified during the course of six years research on the project, as the potentialities and implications of various aspects of the structural form became clearer. The paper describes the development of the principal characteristics of the Seafox designs and the reasons for adopting them. Testing of models in wave tanks and complementary computer analyses are described, with illustrations being given of some of the model types tested. Related research on safety aspects of the designs and costing studies are discussed. Examples are given of Seafox Tethered Buoyant Platforms for deep water oil production applications. 14 figures.

4379 **Deep sea production use of articulated columns.** Moinard, M.A.E. (Societe Nationale ELF-AQUITAINE, Pau, France). pp 1010-1033 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Experiments on the ELF OCEAN prototype have led to the first petroleum installations based on an articulated structure, designed for basic functions such as loading stations or flare stack supports. Study has since been undertaken to enable articulated columns to perform more complex petroleum functions. Two groups of applications have been developed, depending on whether the production unit consists of an articulated column alone or results from its combination with a floating support. In the first case, the articulated structure carries the production equipment - this is the production column, or the service column for the subsea well. In the second, the processing installations are mounted on a semi-submersible platform or vessel, and the column essentially acts as permanent or semi-permanent riser and single anchorage point. Detailed engineering work, together with tests in the testing tank and on prototype equipment provide support for the projects studied as whole. Adaptations of articulated columns to the various petroleum functions first involved structures with a single articulation capable already today of providing answers to development problems down to depths of water of about 400 metres. Beyond such depths lies the field of application of multi-articulated columns, where further development studies should be made. 9 figures.

4380 **Seabed hydrocarbon production.** Derrington, J.A. (Sir Robert McAlpine and Sons Ltd., London, England); Collard, M.J.; Skillman, J.M. pp 1053-1070 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

This paper reviews the development work presently being undertaken by DSPS to establish the technical feasibility and financial viability of a production system located on the seabed to exploit the deep water oil and gas reserves. In 1975 Sir Robert McAlpine and Sons started work on the concept, using reinforced concrete pressure hulls to house conventional equipment in a dry one atmosphere environment. By the beginning of 1978 the consortium, named DEEP SEA PRODUCTION SYSTEMS (DSPS), had been formed with three other companies, and with the help of E.E.C. funding, a Phase I Feasibility Study was started in January 1978. The objective of Phase I is to establish the engineering and economic limits of the seabed concept; a variety of applications for different field types is being considered in water depths from 200 to 1000 metres. Phase I is due to be completed in June 1979, and this

paper presents only the concept and a general description of the designs being developed, and does not at this point, present final results or conclusions from the work. Complete seabed facilities - including oil and gas separation, water injection and gas re-injection - are described and discussed together with surface facilities for tanker loading, power generation and gas flaring. 3 references, 7 figures, 1 table.

4381 **Pilot installation for the recovery of heavy crude by steam injection into the LACQ field.** Sahuquet, B. (Societe Nationale Elf Aquitaine, Pau, France). pp 1111-1122 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The recovery of high viscosity crudes by thermal methods, mainly steam recovery, is an already proven method, and has even been applied on industrial scale, among other places in the USA and Venezuela. However, these methods have been used almost without exception only on relatively homogeneous sandstone reservoirs. The twofold feature of the pilot test made by the SNEA(P) on the UPPER LACQ field is that steam injection is applied to a deposit which is firstly carbonated and secondly highly fissured in which the network of fissures may result in irregular advance of the hot zones and consequently make the method inoperative. It must nonetheless be pointed out that the density of the fissures is very high, since the dimensions of the matrix blocks can be measured in decimetres or metres at the most. In the UPPER LACQ field, the pilot installation zone consists of an injection well with six production wells around it. The average spacing is 200 metres. Injection of steam started in October 1977 at an average rate of 160 tons per day and the cumulative quantity injected by the end of December 1978 was 65,000 tons. The pattern of development was followed by means of down-hole temperature measurements, analyses of the water produced, injection of trace elements in the steam and measurements of the pressures. The effectiveness was appraised on the basis of the increase in the output of the peripheral wells. According to the initial results obtained, the recovery process would appear to be spreading fairly uniformly, affected only little by the fracturation network. Furthermore, on certain wells, oil production has improved distinctly: the average oil output from wells in the immediate vicinity of the central injection well increased from 25 to about 60 m^3 per day. The quantities of injection water produced so far are minimal. 3 figures.

4382 **Initial resuls of pilot injection of microemulsion on Chateaurenard Field.** Chevalier, J.P.; Philippot, H.; Putz, A.; Stock, G. (Societe Natrional Elf Aquitaine, Saint-Martory, France). pp 1142-1161 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

In France the ELF AQUITAINE group operates a pilot installation for injecting microemulsion into Chateaurenard Field. This operation is subsidized by the E.E.C. and enjoys the benefit of the collaboration of the Institut Francais du Petrole (French Petroleum Institute). The field lies at a depth of 600 metres and consists of a layer of unconsolidated clayey sands 3 metres thick containing a relatively viscous crude (40 centipoises). The pilot panel is an inverse five spot with sides 100 metres long and an intermediate observation well located between the injection well and a producer well. The microemulsion plug based on petroleum sulfonates was injected at the start of 1978 and has been displaced since March 1978 by a solution of polycrylamides. Excellent results were obtained, since two months after starting injecting, oil output rose from 100 m^3 to 350 m^3 per month. The operation is to continue until the end of 1979, at which time the final overall results will be determined. 6 figures, 1 table.

4383 **Research on approved hydrocarbon recovery from chalk deposits.** Luque, R.F.; Duns, H.; van der Vlis, A.C. (Shell Research, Rijswijk, Netherlands). pp 1162-1170 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The final conclusion of the chalk project is that highly porous but tight chalk reservoirs can be made commercially productive by draining them through highly deviated selectively stimulated drainholes. These must be drilled perpendicular to the least in-situ principal stress to ensure optimum inflow from the fractures. The fracture orientation in the reservoir must therefore be pre-determined. It can be predicted from geological studies and it can also be detected with a fracture finding tool in a vertical open hole after a mini-frac test. High-angle wells should be stimulated selectively in five stages using ball sealers for diversion: in soft chalk reservoirs with a combined acid/propped fracturing treatment; and in more competent chalk reservoirs with an acid-fracturing treatment, utilizing the viscous fingering technique. The critical pore-collapse pressure of the reservoir chalk should be pre-determined in the laboratory and the reservoir should be produced below that critical rock pressure. These combined techniques will result in: considerable savings in development costs; and important savings in floor space on offshore platforms. The promising results of research justify field testing of these combined techniques in a tight-chalk reservoir. It should be emphasized that the application of high-angle wells is not necessarily limited to tight-chalk reservoirs but might equally well find application in other cases such as sandstone and limestone reservoirs. An additional application may be in water-injection wells to improve sweep efficiency.

0206 Health And Safety

REFER ALSO TO CITATION(S) 4359

0207 Marketing And Economics

REFER ALSO TO CITATION(S) 4629

4384 **(DOE/CS/50007—1-Vol.1) Impacts of alcohol fuels on the US refining industry. Volume 1. Summary.** Dickson, J.C.; Frederick, F.P.; Sipowicz, W.W. (Bonner and Moore Management Science, Houston, TX (USA)). Aug 1983. Contract AC01-81CS50007. 135p. NTIS, PC A07/MF A01. Order Number DE84003905.

The study reported here was conceived and executed to assess the impact alcohols, as a vehicle fuel or as fuel components, would have on the US petroleum refining industry. Both the kinds of impacts to be assessed and the manner in which alcohol might be used were part of the study design. Use of alcohol was defined, therefore, as a future in which alcohols are employed as a neat fuel or one where alcohols are used as constituents of blended gasolines. Whether as a substitute fuel or as a gasoline component, alcohol use will impact refiners in terms of operations, costs and planning. Assessing these impacts was accomplished by studying the behavior of two sets of mathematical models of refining operations. One set was composed of regional composite-refinery models which were used to find the optimum balance of operating and capital costs under specified future conditions. The other set of models, referred to as simulation models, was used to examine a series of specific refining situations, intended to encompass those which individual refiners may encounter. The first set produced results pertaining to industry-wide response to, and impacts from, alcohol use. The second set produced results which shed some light on the individual refiner's response to the product markets resulting from the whole industry's response to alcohol use. This study has limited its perspective to that of the refining industry and its scope to the comparison of four future situations. One is without alcohol. One assumes use of alcohol as a neat fuel. The other two assume that methanol and ethanol will be used as blending components. The future in all cases refers to 1990. This study has not examined the problems of transition to

an alcohol future, the viability of alcohol manufacture nor the use of alcohol for other than highway vehicle fuels. 10 figures, 75 tables.

4385 **(DOE/EIA—0035(83/11)) Monthly energy review.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). Nov 1983. 118p. NTIS, PC A06/MF A01. Order Number DE84003902.

Current data is presented on production, consumption, stocks, imports, exports and prices of the principal energy commodities in the US. Also included are data on international production of crude oil, consumption of petroleum products, petroleum stocks, and production of electric power from nuclear powered facilities. Feature article for this issue is exploring for oil and gas. (PSB)

4386 **(DOE/EIA—0380(83/10)) Petroleum marketing monthly.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). Oct 1983. 104p. NTIS, PC A06/MF A01 - GPO. Order Number DE84002152.

Portions are illegible in microfiche products.

Information and statistical data are given about a variety of petroleum products, including motor gasoline, distillates, residuals, jet fuel, kerosene, and propane. The publication provides petroleum products sales statistics for use by industry, government, and private sector analysts, educational institutions, and consumers.

4387 **(GAO/NSIAD—83-08) Prospects for long-term US steam coal exports to European and Pacific rim markets.** (General Accounting Office, Washington, DC (USA). National Security and International Affairs Div.). 4 Aug 1983. 49p. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20760.

US exports of coal used for electricity generation and industrial heating are expected to increase in volume over the long term, but they probably will remain a small portion of total US coal production. Other countries have much lower production and delivery costs and could underprice US exporters by significant margins but choose to price their coal only marginally below US prices to maximize their profits. Therefore, the US market share will be subject to the pricing strategies of major competitors.

4388 **(NP—84900339) Future of crude oil prices.** Robinson, C. (Surrey Univ., Guildford (UK)). Nov 1982. 26p. NTIS, PC A03/MF A01. Order Number DE84900339.

The author concludes that accurate price forecasting is improbable as judged by past failures; however, the slightly increasing world demand for oil is likely to keep the price floor also gradually increasing. He uses a working increase of 1 to 5% per annum for real increases. (PSB)

0210 Legislation And Regulation

REFER ALSO TO CITATION(S) 4359

4389 **(NP—4900026) 1982 legal report of oil and gas conservation activities.** (Interstate Oil Compact Commission, Oklahoma City, OK (USA)). Oct 1983. 41p. Interstate Oil Compact Commission, P.O. Box 53127, Oklahoma City, OK 73152.

When the Interstate Oil Compact Commission was formed in 1935, it was for the purpose of promoting the conservation of oil and gas and the prevention of physical waste thereof. Over the years, the commission has taken every opportunity to fulfill this purpose. One of the most important functions of the IOCC is the dissemination of information in the form of printed reports, pamphlets and books for general distribution to state conservation agencies, the public and members of the industry. This Legal Report of Oil and Gas Conservation Activities has long been recognized as an outstanding vehicle for this purpose, as it provides a means of reporting legal activities which have taken place throughtout the United States and Canada during the prior year. This report for the year 1982 is the thirty-fourth annual issue. It includes articles from 31 states and the Canadian provinces of Alberta and British Columbia. Some states are not included in this publication, since their reporters stated that their states had no significant legal activities dealing with oil and gas conservation during the year 1982 on which to report. These annual Legal Reports are, in effect, supplements to the books, Conservation of Oil and Gas - A Legal History, 1948 and Conservation of Oil and Gas - A Legal History, 1948-1958, published by the Mineral Section of the American Bar Association.

0220 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 4359, 4375

4390 **J-configuration laying of large diameter pipelines.** de Sivry, B.; Raven, J.H. pp 1073-1085 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Conventional laying is limited to a depth of 400 to 600 metres because of the anchoring capacity of the supports. For greater depths, the use of dynamically positioned superbarges would call for considerable installed capacities. On the other hand, the laying method using a J curve appears highly interesting for great depths. The problems inherent in laying can be solved easily by technical solutions approaching those used on a drilling support. Nonetheless, the rational use of this method calls for the development of a rapid welding method using a single welding station. Electron-beam welding, which is well adapted to the considerable thicknesses and high grades of steel employed have provided a solution to this problem. A feasibility study has enabled the problems of positioning the tubes and obtaining a vacuum to be solved through verification on a full scale test bench. The metallurgical study has resulted in welds with good characteristics in high grade API steels. These results now justify the construction and testing of a prototype. 5 figures.

0240 Storage

REFER ALSO TO CITATION(S) 4357

0250 Combustion

REFER ALSO TO CITATION(S) 4352

03 NATURAL GAS

0302 Geology And Exploration

REFER ALSO TO CITATION(S) 4359, 4360, 4361, 4363, 4364, 4365, 4375

4391 **Brine production as an exploration tool for water drive gas reservoirs.** Randolph, P.L. (Inst. of Gas Technology, Chicago, IL). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 1066-1071(Aug 1982). (CONF-820814—). Contract AC08-80ET27081.

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

Data from detailed analyses of production from geopressured geothermal aquifers suggest that appropriate brine production tests may well result in production of otherwise undiscoverable hydrocarbons. This paper reviews concepts for the biogenic origin of natural gas, subsurface migration of natural gas, and trapping of that gas in commercially producible reservoirs. Data are presented to demonstrate discovery of free natural gas by brine production from two "dry" wildcat wells. Finally, conditions under which brine production testing may be a prudent investment are discussed.

0303 Drilling, Production, And Processing

REFER ALSO TO CITATION(S) 4368, 4369, 4375, 4376, 4380, 4394, 5113, 5159, 5160

4392 The offset well test an engineering study of Devonian shale production characteristics. Fromne, K.H.; Komar, C.A. (U.S. Department of Energy, Morgantown, West Virginia). *Proceedings, Intersociety Energy Conversion Engineering Conference;* 2: vp(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

A reservoir interference test was conducted in an established shale gas field to quantitively determine the gas production characteristics of the naturally fractured Devonian shale formation. The test utilized an established producing well and two newly drilled monitoring wells offsetting the producer on the secondary and primary regional fracture trends. The test was located in Meigs County, Ohio, and addressed investigation of the following reservoir properties: flow characteristics of gas, orientation and distribution of natural fractures, storage and release mechanisms of gas, and impact of directional flow on production practices. Test results indicate extreme reservoir permeability anisotropy, suggesting that the preferential well drainage pattern of the fractured shale is elliptical. Virtually all of the free gas is stored sorbed in the matrix, and natural fractures primarily provide conduits for gas transport. Study findings impact infill drilling considerations and overall gas recovery efficiency from fractured shale.

0304 Products And By-products

REFER ALSO TO CITATION(S) 4395, 4404

4393 Development and model testing of a floating natural gas liquefaction plant. Meyer-Detring, D. (Preussag AG Erdol and Erdgas, Hannover, Germany). pp 1173-1190 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Offshore natural gas production by liquefaction on floating structures, followed by unloading and transportation in LNG carriers, promises to be advantageous over conventional methods for conveying natural gas to consumers in pipelines. This is especially so for marginal offshore gas fields, or offshore oil fields with associated gas or even for onshore fields where there is a lack of infrastructure. The proposed systems fill a market gap where fixed platform/subsea pipeline methods or onshore LNG plants have reached the limit of economic viability. The processing of natural gas on floating platforms presents many challenging problems associated with the motions of the platform, the need for maximum gas recovery, minimum space and weight requirements for the processing plant and maximum safety for men and equipment. Two groups of companies, ARGE 76 and CONSORTIUM 76, have developed several alternatives of floating LNG plants for different applications and have formed the common OLS marketing group to market offshore LNG plants. This paper presents the CONSORTIUM 76 design, a natural gas liquefaction system integrating LNG plant, LNG storage tanks and LNG unloading system on one single platform. The CONSORTIUM 76 design has been developed by the companies Linde, Preussag, Technigaz, Dyckerhoff and Widmann, Blohm + Voss and Bilfinger + Berger. 13 figures.

4394 Natural gas production systems for the North Sea based on liquefied natural gas and methanol. Kramer, J. (Salzgitter Ferngas GmbH, Germany). pp 1203-1218 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Process engineering plants for utilization of gaseous hydrocarbons at offshore locations, primarily in Northern Europe, will take the lead in future offshore technology not only because of possible political crises but also for economic reasons. Target areas for the LNG and methanol production system presented in this paper are the natural gas and associated gas fields in the North Sea and other shelf regions. For certain offshore gas fields, the prospect of developing these resources using conventional pipeline technology is economically dubious. Offshore natural gas technology (liquefied natural gas and methanol) permits highly mobile production and transportation of natural gas and improves the break-even point in favor of smaller marginal fields. The offshore liquefied natural gas system developed within the framework of a joint-venture project comprises: natural gas liquefaction plant for 10^6G cal/d and storage tanks; removable platforms for water depths up to 200 m; and liquefied gas transfer system and 50,000 m^3 LNG carriers. The offshore methanol system is made up of the following components: methanol processing plant for 3000 t/d; removable platforms; and SALM transfer system and subsea storage facilities for 160,000 m^3. 5 figures.

0305 Health And Safety

REFER ALSO TO CITATION(S) 4359, 4404

4395 Approach to the risk evaluation of a floating LNG production system. Usterud, O.; Schamaun, P. (Aker Engineering A/S, Oslo, Norway). pp 1271-1286 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The risk evaluation has been carried out in order to establish the overall safety aspects of a floating natural gas liquefaction plant for offshore loading and storage of associated gas. The hazards that may jeopardize the platforms and their crew have been identified. The total concept has been split into sub-systems. The hazards have then been considered with regard to their effect on each subsystem. The design and protective measures have been evaluated to highlight any hazard which seemed inadequately covered. This exercise has provided design recommendations which will improve the overall safety. The reason for carrying out this kind of analysis is to enable a systematic approach to the safety design and to provide an adequated documentation for the regulatory bodies. 7 figures.

0306 Marketing And Economics

REFER ALSO TO CITATION(S) 4400

4396 (GAO/RCED—83-3) Need to revise eligibility criterion for one natural gas price category and eliminate backlog in refund control work. (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 18 Aug 1983. 62p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to the Chairman, Federal Energy Regulatory Commission.

The Natural Gas Policy Act of 1978 created eight price categories for natural gas and set the criteria for charging each price. GAO found that the Commission's implementing regulations for one higher priced category included natural gas that the Congress did not intend to include. The Commission had over a 3-year backlog at the end of fiscal year 1982 in its program to detect and require refunds of overcharges in various categories and has been slow in reducing that backlog. A large continuing backlog could adversely affect the orderly completion of the compliance program when price controls end. GAO recommends that the Commission revise its criterion for the one category and eliminate the refund control backlog.

4397 **Economics for nonassociated gas production by field size, depth, and region.** Wood, J.H. (Energy Information Admin., U.S. DOE). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* No. SPE 11293, 49-60(Mar 1983). (CONF-830386—).

This paper presents the relative economics to develop and produce non-associated gas from nine field sizes at four depths in eight U.S. regions. Exploration costs are excluded. In general, for a given field size it requires roughly twice the price to yield the same discounted cash flow rate of return as depth increases from 7,500 to 12,500 feet. The price roughly doubles again in going from 12,500 feet to 17,500 feet. At each depth, a large increase in price was required for economic development as field size decreases. Regional factors can also have a significant bearing on field economics especially where drilling and operating costs are exceptionally high.

0308 Environmental Effects

REFER ALSO TO CITATION(S) 4402

0309 Artificial Stimulation

4398 **(SAND—83-0625) Hybrid analytical/numerical computation of heat transfer in a gas-driven fracture.** Griffiths, S.K.; Nilson, R.H.; Morrison, F.A. Jr. (Sandia National Labs., Albuquerque, NM (USA)). Oct 1983. Contract AC04-76DP00789. 34p. NTIS, PC A03/MF A01. Order Number DE84002986.

In gas-driven hydraulic fractures, as occur in rock blasting and underground nuclear testing, the high temperature gases (1000 to 30,000 K) are radically cooled by heat transfer to the host material. This significantly reduces both the maximum extent and rate of fracture growth. The coupled processes of fluid flow, heat transfer, and rock deformation governing fracture growth are calculated here by a hybrid analytical/numerical procedure. The gas motion along a fracture of increasing length and aperture is described by a finite-difference form of the one-dimensional transport equations; fluid friction, advective heat transfer and heat loss to the walls of the fracture are considered. Lateral heat losses are evaluated in a quasi-analytical fashion, based on an integral method, that accounts for the convective film resistance between the fluid and fracture wall, as well as the conductive resistance within the surrounding medium. The calculations are performed on a difference grid that expands to maintain a fixed number of points uniformly distributed along the fracture. The present numerical results agree, in appropriate limits, with known similarity solutions. Beyond this, new nonsimilar solutions for early-time fracture growth are presented.

4399 **The Multi-Well Experiment: a field laboratory for tight gas sands research.** Sattler, A.R. (Sandia National Laboratories, Albuquerque, NM). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 1027-1032(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

The Multi-Well Experiment (MWX) is a research oriented field laboratory whose objective is developing the understanding and technology to allow economic production of the over 200 trillion cubic feet of natural gas estimated to lie within the low permeability, lenticular gas sands in the western United States. Experiment activities include: close-spaced (100-200 ft) wells, comprehensive core and logging programs, extensive in situ stress measurements, geophysical surveys to determine sand body configurations, diagnostic measurements for hydraulic fracture characterization, and a series of stimulation experiments. Analysis of data from these activities will yield improved geologic, reservoir, and stimulation models and improved log interpretation methods for lenticular, tight gas sands. To date, two 8350 ft wells, 135 ft apart, have been drilled in the Piceance Basin at a site near Rifle, Colorado, where the Mesaverde, the formation of interest, lies at a depth of 3900-8300 ft. Preliminary core, log, and well data have provided an initial characterization of the site. Four years of stimulation experiments are planned for this field laboratory.

0310 Legislation And Regulation

REFER ALSO TO CITATION(S) 4359, 4389, 4396

4400 **(DOE/EIA—0404) Producer revenues, prices, and concentration in the natural gas market.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). Nov 1983. 84p. NTIS, PC A05/MF A01 - GPO. Order Number DE84003189.

In this study natural gas producers are divided into three classes which are: major integrated producing companies, major interstate pipelines and affiliated producers, and independent producers. A producer is included in a particular class based upon size and corporate structure. The major integrated producing companies are very large, have downstream operations on the oil side, but virtually no interstate pipeline operations. The major interstate transmission companies and their affiliates are managed by corporations that must consider the effects of production pricing policy on the pipeline and other downstream operations. The independent producer's interest is principally as a producer of oil and gas, with little direct interest in the other aspects of the natural gas market. The objective of this study of natural gas producer sales and current price levels is to evaluate the relative positions of different classes of gas producers by examining possible revenue changes which theoretically may be realized by producers given total decontrol of wellhead natural gas prices and complete renegotiation of natural gas contracts at the wellhead. The study does not specifically address any proposal currently before the Congress, but analyzes a simplified case of the impacts of immediate and complete decontrol and renegotiation of all contracts to a single market clearing price.

4401 **(GAO/ID—83-31) European alternatives to importing Soviet natural gas.** (General Accounting Office, Washington, DC (USA). International Div.). 16 May 1983. 29p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to Senator Lloyd M. Bentsen.

For the Europeans, there is no simple alternative to natural gas from the Soviet pipeline. Problems, such as those associated with security of supply, technical feasibility, and cost, eliminated alternatives as either not readily available or not in line with basic European energy strategies. This is not to suggest that, in the longer term, alternatives will not be available to offset, at least in part, the need for future European imports of Soviet gas. Following repeated US expressions of concern about European vulnerability to possible Soviet supply interruptions, the Europeans have begun to identify ways to improve contingency planning and reduce the impact of any disruptions. Also, a number of European leaders have agreed to forego any further contracts for Soviet gas pending completion of a multinational study.

0320 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 4359, 4375, 4390, 4393, 4394, 4395

4402 **Tennessee/Boundary looping project, Tennessee Gas Pipeline Company, docket no. CP81-296-000.** *EIS (Environmental Impact Statements);* **6**: No. 9, 11-12(Sep 1982).

Issuance of a certificate of public convenience and necessity for the construction and operation of 261.4 miles of pipeline loop in Connecticut, Massachusetts, New Hampshire, New Jersey, New York, and Pennsylvania is proposed. The facilities, which would be run by the Tennessee Gas Pipeline Company, would transport Canadian gas proposed for import by the company and by Boundary Gas, Inc. from Trans-Canada Pipe Lines, Limited. The loop pipeline project would consist of 10-, 12-, 30-, and 42-inch diameter pipelines in 19 segments adjacent to existing pipelines in affected states. Two new compressor stations and installation of additional horsepower or improvement of compressor units at four existing compressor stations would be needed. New or modified metering and regulating facilities would also be installed.Positive and negative impacts are given.

4403 **Testing of laying of a gas pipeline in the Strait of Messina and the Silicilian Channel.** Pedrazzini, A. (SNAM SpA, San Donato Milanese, Italy). pp 1086-1108 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Fifteen kilometres of 10-inch (254.0 mm) diameter pipeline were laid in 1974 in the Strait of Messina and in 1976, 3.2 kilometres of 12 3/4-inch (323.85 mm) pipeline and 3.5 kilometres of 16-inch (406.4 mm) pipeline in the Sicilian Channel. The maximum depths reached were 360 and 550 metres, respectively. These tests, which were carried out with the financial support granted in accordance with the EEC 3056/73 decision, form part of the project for importing 12,400 million cubic metres of natural gas per year from Algeria to Italy, to start during October 1981 in accordance with a program of gradually increasing quantities. The tests yielded satisfactory results and have made it possible to launch the implementation program for this work. Laying of three 20-inch (508 mm) pipelines in the Strait of Messina was to start during 1978. 7 figures.

4404 **LNG handling offshore: submarine LNG piping and a flexible submarine LNG connection for an articulated loading tower.** Backhaus, H. (LGA Gastechnik GmbH, Remagen-Rolandseck, Germany). pp 1191-1202 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The offshore liquefaction of natural gas from submarine reservoirs has been under discussion for many years. The intensive developments within various European countries, and in particular in the Federal Republic of Germany has proven the technical feasibility of different offshore liquefaction systems. At the same time great efforts have been made to develop offshore loading devices to enable the cold liquid LNG to be transferred from the production platform to the transporting tanker. It is the opinion of the author that an LNG handling system which can be operated successfully under severe sea conditions can only be realized by joint development of various disciplines: special aspects of tanker design and tanker maneuvering dominate the technical problems of pipeline construction, towing, positioning and its operation with the cryogenic liquid LNG. An optimum solution of these complex problems can only be found if an extensive risk analysis proves that maximum safety for the operational and maintenance personnel is achieved. This also is true for the invested capital, and last but not least, for the uninterrupted supply of LNG to the market. The author will endeavor to describe such an adequate system in this paper. 4 figures.

4405 **LNG carrier.** Verolme, C. (Naval Project Development Co., Rotterdam, Netherlands). pp 1219-1223 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

During a number of years Gastech has yearly held a congress which has been visited worldwide by specialists in designing and building ships suitable for the transport of LNG. Especially during the last three years (in New York, Duesseldorf, Monaco) these conferences have drawn big audiences and everybody could communicate on large scale by visiting the lectures about the LNG transport problems. Very open comparison with the different ship types was possible. The Verolme LNG carrier can be built in any size up to 500,000 m^3. The principle is the transport capacity being the same as that of the VLCC for oil transport. The main advantage of the Verolme design is the safety in case of collision or standing since no gas is lost by the strength of double bottom and deck. The multi-container system may be a little more expensive but it is fully safe. A reduction of 30 to 40% in transport costs in comparison with the small LNG carrier is another advantage just like the draft being for all sizes about 40 feet. The cryogenic part is of aluminum, the separate containers are well-secured to the hull. The small ship is single-screw, the large one twin-screw. Partial loaidng is possible on each draft.

4406 **LNG offshore loading system.** Ehret, T. (F.M.C. Europe S.A., Sens, France). pp 1224-1237 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The development of an LNG offshore loading system has been undertaken by FMC, with EEC support, in late 1978. The initial investigations are presented from a reliability view point, through a description of the system specifications, including a risk analysis, and a description of the main features of the solution being developed: all metal link; field proven cryogenic swivel joints; computerized monitoring and control system; tensioning system for connection/disconnection operations; and dry break system. The main steps of the development program in 1979 and 1980 are described. 3 figures.

04 OIL SHALES AND TAR SANDS

0401 Reserves And Exploration

4407 **(NP—4900340) Investigation of subsurface tar-sand deposits in western Kentucky. A preliminary study of the Big Clifty Sandstone Member of the Golconda Formation (Mississippian) in Butler County and parts of Edmonson, Grayson, Logan, and Warren Counties. Information Circular 7, Series XI, 1982.** Williams, D.A.; Noger, M.C.; Gooding, P.J. (Kentucky Geological Survey, Lexington (USA)). 1982. 51p. NTIS, PC A04/MF A01. Order Number DE84900340.

Tar sands (also referred to as asphaltic sandstones, heavy-oil deposits, or bitumen-impregnated sandstones) in western Kentucky have been recognized as a potential mineral resource for over 100 years. Past commercial development has been restricted largely to use as paving material. However, because of the ever-expanding demands for energy, these deposits have become the subject of increasing interest as a potential petroleum resource. Previous studies have provided estimates of the potential resources of shallow mineable tar-sand deposits; these investigations have concentrated on the outcrop areas where tar sands are present at or near the surface. Data on subsurface deposits have been lacking, however, and currently no reports are available which evaluate the potential oil resources associated with the occurrences of deeper tar-sand deposits in western Kentucky. The Kentucky Geological Survey has initiated a project to inventory and evaluate the oil-resource potential of asphaltic sandstones in the subsurface of western Kentucky. The purpose of this report is to evaluate the subsurface occurrences of asphaltic sandstones in the Big Clifty Sandstone Member of the Golconda Formation in a portion of the tar-sand area of western Kentucky. This evaluation is based on a compilation of published information and data available in the files of the Kentucky Geological Survey. Acquisition of new data, primarily by core drilling, will be necessary before any reliable estimate of the total volume of this potential oil resource can be attempted.

0404 Oil Production, Recovery, And Refining

4408 **(ESG-DOE—13406) Application of hydropyrolysis to the hydroconversion of Eastern oil shale. Final technical report.** Falk, A.Y.; Garey, M.P.; Rosemary, J.K. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Nov 1983. Contract AC01-82FE40013. 148p. NTIS, PC A07/MF A01. Order Number DE84003010.

The two major objectives of the project were: (1) testing, data reduction, and chemical analysis to determine the performance of Eastern oil shale in a hydropyrolysis reactor; and (2) selection of an operating point suited to high yields of shale oil and performance of a preliminary process analysis and economic assessment of

the process. Six tests were conducted in the 1-TPH process development unit (PDU) at 1100 and 1400°F, nominal reactor residence times of 75 and 200 ms, and a reactor pressure of 1000 psig. A blend of Cleveland Member of the Ohio shale, pulverized to 70% through 200 mesh, was used as feedstock. Excellent material balances were obtained for the test series, which had an average test duration of 68 min and an average shale throughput of 1688 lb. Total carbon conversions as high as 70.0% and carbon conversions to liquids as high as 55.5% were found. Production of raw shale oil ranged from approximately 13.5 to 19.0 gal/ton of shale fed compared with a Fischer assay of approximately 13 gal/ton. Nitrogen and sulfur concentrations in the untreated whole oil were approximately 2.2 and 1.6 wt. %, respectively, and very low hydrogen consumption in the reactor was observed. Excellent data correlation was obtained as a function of reactor severity, expressed as carbon conversion to methane. Based on a selected operating point, a conceptual design was developed for a commercial-scale plant producing 50,000 bbl/day of partially hydrotreated shale oil, suitable as refinery feedstock. Product oil yield is approximately 21 gal/ton of dry shale. Input to the plant consists of 4150 TPH of dry shale and imported methane. The estimated plant investment is approximately $2 billion in first-quarter 1983 dollars, including a 15% project contingency. The calculated average product selling price is $35.20/bbl.

4409 **(NERDDP-EG—82-40) Julia Creek project - shale oil retorting investigation.** (National Energy Research Development and Demonstration Council, Canberra (Australia)). 1983. vp. National Energy Research Development and Demonstration Council, Canberra, Australia.

Twenty retorting trials were carried out in the modified ocntinuous pilot retort at CSR, to investigate retorting Julia Creek oil shale at different temperatures. The range of retorting temperatures investigated was 450 deg C to 565 deg C. Only slight changes were made in the feed throughputs and retort dwell times for the trials. Various inert gases (nitrogen, argon, and carbon dioxide) and recycled retort gas were used to sweep the product vapours from the retort. The retorting investigations are reported.

4410 (PNL-SA—11552, pp 178-200) **Influence of chemical characterization of oil shale solids on understanding water quality impacts.** Peterson, E.J.; Wagner, P. (Los Alamos National Lab., NM). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The importance of solids characterization in the assessment of health and environmental consequences of oil shale processing has been discussed. This type of information is essential for the understanding of water quality impacts from energy development. A variety of issues can be addressed aided by solids characterization information. First, the role of process parameters in the formation of wastes and effluents can be determined. Second, the mineral/water interaction during leaching and/or weathering can be understood. Third, the influence of the microstructure of the solids on the leaching process can be investigated. Fourth, the availability of major ions for solubility control is determined by spent mineral assemblages. Finally, trace element residences and their role in contaminant mobility can be understood. The data presented in this report indicate that the spent shale wastes retrieved from Logan Wash retort 3E are a function of the material being processed and the process conditions. An understanding of the interaction of the raw material and the process in waste formation aids the interpretation of the chemistry of effluent streams and leachates. Regarding trace element contaminants in leachates, mineral residences as well as solution chemical control determine mobility. Water quality may also be affected by leaching of soluble material from the spent shale. However, most of the constituents that occur at elevated concentrations in the leachates are also present at elevated concentrations in the predevelopment groundwater. This occurs because the aquifers in the area are composed of raw shale. Thus, leaching may not significantly affect the suitability of these waters for beneficial uses. There are a few exceptions noted.

4411 **Pyrolysis kinetics for western and eastern oil shale.** Burnham, A.K.; Coburn, T.T.; Richardson, J.H. (Univ. of California, Livermore, CA). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 912-917(Aug 1982). (CONF-820814—). Contract W-7405-ENG-48.

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

Oil yield and kinetic results are reviewed for Western (Colorado Mahogany zone) and Eastern (Sunbury and Ohio (Cleveland member)) oil shales for conditions ranging from those encountered in in-situ processing to those in fluidized-bed retorting. The authors briefly summarize kinetic models for the pyrolysis reactions. Oil yields from Eastern shale are much more sensitive to pyrolysis conditions than Western shale.

4412 **Distillate fuels from Green River oil shale.** Sullivan, R.F. (Chevron Research Co., Richmond, CA). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 924-929(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

Shale oil is notable for its high nitrogen content and for large amounts of unsaturated and metallic contaminants. However, although expensive to refine, shale oil can be upgraded to specification transportation fuels using commercially available petroleum processing technology. The key is an effective initial hydrotreating step in which most of the contaminants are removed. The syncrude thus produced can then be refined in petroleum refineries using conventional technology such as hydrocracking, catalytic cracking, and catalytic reforming to give specification transportation fuels. This paper discusses upgrading options, the properties of fuels from shale oil, and reviews Chevron's plans for commercial development.

4413 **Applications of nuclear magnetic resonance to oil shale processing.** Miknis, F. (U.S. Department of Energy, Laramie, WY). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 935-939(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

The solid state NMR techniques of cross polarization with magic angle spinning have been employed to characterize the organic carbon distribution in raw, partially and fully retorted oil shales. NMR measurements of a Colorado oil shale heated to various retorting temperatures for a fixed time period show a depletion of the aliphatic carbon fraction relative to the aromatic carbon fraction. This depletion becomes more pronounced with increasing temperature. NMR measurements of the carbon distribution of several different types of oil shales show that residual carbon in retorted oil shales is almost exclusively aromatic. The results suggest that the residual carbon in retorted oil shales originates from the aromatic carbon fraction already present in the raw oil shale.

4414 **Incipient fluidization characteristics of crushed oil shale.** Christiansen, D.E. (University of California, Livermore, CA). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **2**: 940-945(Aug 1982). (CONF-820814—). Contract W-7405-ENG-48.

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

The authors have measured the gas velocity for incipient fluidization of crushed shale as a function of particle size, shale grade, crushing method and temperature. This velocity varied as the square of particle size for 0.0063 to 0.1-cm particles and approximately as the square root of particle size for 0.5-cm particles. The authors observed no regular dependence of this velocity upon shale grade. Slightly higher velocities were found for cone-crushed than for hammer-milled shale particles. For 0.0125 to 0.10-cm particles the authors found that raising the temperature to 450°C reduced the velocity by 28 percent from 20°C measurements. The Zenz-Othmer graph predicts velocities three to five times higher than those observed. The Kunii-Levenspiel correlation predicted velocities 25 to 270 percent higher than observed at 20°C but was within experimental error for measurements at 450°C.

4415 **Pyrolysis of oil shale and related organic compounds in supercritical steam.** Tyler, A.L. (University of Utah, Salt Lake City, Utah). *Energy Technology (Washington, D.C.);* 9: 578-587(Jun 1982). (CONF-820217—).

From 9. energy technology conference; Washington, DC, USA (16 Feb 1982).

The pyrolysis of oil shale from the Green River Formation and from Australia has been studied in supercritical steam in an Autoclave reactor. In addition, three model compounds (polyethylene, polystyrene, cholesterol) have been similarly pyrolyzed in supercritical steam. The analytical method consisted of vaporizing the sample and passing it through three parallel paths containing absorbers. The output from each path was detected separately with an FID in a gas chromatograph. The analytical method was definitive for small molecules, but often ambiguous for larger, more complex species. The chemical complexity of the oil pyrolzates necessitated defining the hydrocarbon types in terms of the analytical method for these mixtures. The olefin content of the oil pyrolyzates from Australian Mt. Coolaway Torbanite and Glen Davis oil shale fell from approximately 50% for the "dry" pyrolysis to approximately 20% for oil produced in supercritical steam. Oils produced from the U.S. (Green River) oil shale showed a similar effect; but since the oil is heavier and more difficult to analyze, there was greater uncertainty in the numerical value of the compositions. In spite of the limitations of the analytical method, it has been demonstrated that compositions of oil pyrolyzates shift from high olefinic unsaturation to low olefinic unsaturation with the introduction of steam at supercritical conditions during the pyrolysis.

4416 **Production conditions for oil shales of the Toarcian.** Combaz, A. pp 1123-1141 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

Despite a relatively low average oil content (40 to 50 kg per ton), European Toarcian shales represent such vast potential reserves of gaseous and liquid hydrocarbons that the Groupe d'Etudes des Roches Bitumineuses (Bituminous Rock Research Group) has now undertaken study of the feasibility of production from the sources in France, with the support of the EEC. Aside from reconnaissance work in the field, by boreholes and laboratory analyses, the main emphasis has been laid on study of pyrogenation technologies. Accordingly, tests on micropilot installations have made it possible to define the optimum processing conditions leading to an efficiency in the range of that of the Fischer test. Pyrolysis-cracking tests have shown the possibility of obtaining a gas rich in ethylene hydrocarbons, of which 70% is ethylene itself. Furthermore, industrial scale tests have led to an evaluation of the capital and operating cost of an actual open-cast production operation on the basis of 100,000 tons of shale per day. Again, tests have been carried out on the combustion of shales on pellets (≦ 5 mm) and blocks (≦ 250 mm) while simulating in situ pyrolytic combustion conditions. Only for the latter case did the results obtained prove satisfactory, with efficiencies of up to 90% of the Fischer test. The future prospects for such production operations would appear essentially linked to the possibilities of applying in situ production methods. 7 figures, 4 tables.

0405 Properties And Composition

REFER ALSO TO CITATION(S) 4296, 4411, 4419

4417 (PNL-SA—11552, pp 353-373) **Chromatographic chemical class separations in shale oil analysis: the potential of element specific gas chromatographic detection.** Uden, P.C.; Joyce, W.F. (Univ. of Massachusetts, Amherst). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Despite the extremely high resolution and efficiency now available in inert GC columns, the sheer number of components in materials such as shale oil poses difficult problems. Chemical compound class separation schemes that give minimal class overlap have been advocated as initial analytical steps to address the problems of functionality content and trace composition. In subsequent GC investigations of individually separated components, a knowledge of the chemical class involved can greatly increase total effectiveness. Among more successful procedures have been those employing mixed liquid mode separation on Sephadex LH-20, a sequence involving Florisil clean-up, silica, silver-loaded silica and vapor phase molecular sieve subtraction for straight and branched chain alkanes and alkenes, and alkane/fluoroalkane solvent mixtures on silica. In order to obtain the greatest amount of information from GC separation, detector capabilities have an important role. Universal detectors such as the flame ionization detector lack the ability to distinguish compound classes such as those mentioned above. High resolution mass spectrometry may suffice, but is expensive and complex. Specific element detection affords some very useful features of interpretation in combination with class separation and will undoubtedly be developed further in the future. Up to the present, N and S specific detection has been applied in shale oil analysis. A group of class separation studies on both shale oil and separated asphaltene fractions is presented in this paper. Preparative HPLC employing cyano, amino, and phosphate modified amino bonded phases is discussed. Specific element GC detection for nitrogen by thermionic detection and for sulfur by flame photometric detection is reported.

4418 (PNL-SA—11552, pp 381-404) **Interlaboratory comparisons of quantitative analyses of individual compounds in simple and complex mixtures.** May, W.E.; Brown-Thomas, J.M.; Chesler, S.N.; Guenther, F.R.; Hilpert, L.R.; Parris, R.M.; Richie, K.L.; Wise, S.A.; Hertz, H.S. (National Bureau of Standards, Washington, DC). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

SRM 1580 and the NBS values reported for the round-robin shale oil, SRC-II, and Wilmington crude oil samples are now being used as benchmarks for the validation of new analytical procedures and techniques for the determination of selected compounds in complex mixtures. This point is illustrated in Tables 14-20 where various investigators have compared results from their analytical procedures to results reported by NBS as part of their method validation procedures. Over the past five years there has been a steady increase in the comparability of interlaboratory measurements made on the natural mixtures. A comparison of the data given in Tables 14-20 with that in Tables 8-10 reinforces this fact. These data demonstrate the NBS/DOE Quality Assurance program has had a significant positive impact on the organic environmental measurement community.

0407 Health And Safety

REFER ALSO TO CITATION(S) 4301

0410 Enviromental Aspects

REFER ALSO TO CITATION(S) 4410

4419 (PNL-SA—11552, pp 299-316) **Measurement methodologies for the analysis of organic components in oil shale wastewater.** Conditt, M.K.; Hawthorne, S.B.; Williams, E.J.; Sievers, R.E. (Univ. of Colorado, Boulder). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

The extremely complex organic make-up of oil shale wastewaters presents a very difficult analytical problem. As less than 25% of the organic constituents of retort waters have been identified, compound class prefractionation and high resolution techniques, such as GC/MS, should be applied to facilitate better separation and characterization of this complex mixture. In addition, simpler and less expensive analytical methods, such as HPLC, are useful to fingerprint various compound classes in large numbers of

samples on a routine basis. Some of the techniques that may be used to fractionate a compelx sample into compound classes prior to further separation by high resolution chromatography have been presented. The hydrophobic acidic, basic, and neutral compounds may be isolated from retort water using XAD-8 macroreticular resin. Alternatively, the complex-forming constituents may be isolated on a selective sorbent such as Eu(dihed). Also, qualitative and semiquantitative information about the nitrogen bases in retort water may be obtained by HPLC separation and detection of each compound class at the characteristic UV wavelength of its ring system. Each of these methods separates the complex waste-water into compound classes based upon the chemical properties of that class. Such an approach to the analysis of retort water is necessary because, even with the very best high resolution fused silica capillary columns available, the mixtures of volatile organic compounds are so complex that separations without prefractionation are not complete.

05 NUCLEAR FUELS

0502 Exploration

4420 **(N—8326164) Potential of a new technique for remote sensing of hydrocarbon accumulations and blind uranium deposits: Buried LiF thermoluminescence dosimeters.** Siegel, F.R. (Inst. Venezolano de Investigaciones Cientificas, Caracas); Vaz, J.E. (George Washington Univ., Washington, D.C.). (George Washington Univ., Washington, DC (USA)). 1982. 11p. NTIS, PC A14/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 1 p 122-132 (SEE N83-26155 15-43).

Buried thermoluminescence dosimeters may be useful in remote sensing of petroleum and natural gas accumulations and blind uranium deposits. They act as integrating detectors that smooth out the effects of environmental variations that affect other measuring systems and result in irregularities and poor repeatability in measurements made during gas and radiometric surveys.

0505 Enrichment

REFER ALSO TO CITATION(S) 4485, 4487, 4489

4421 **(GAO/EMD—82-88S) Issues concerning the Department of Energy's justification for building the gas centrifuge enrichment plant.** (General Accounting Office, Washington, DC (USA). Energy and Minerals Div.). 24 Jun 1983. 49p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Supplement to a report by the Comptroller General of the United States.

This supplement contains GAO's analysis of and response to the Department of Energy's (DOE's) comments on GAO's May 25, 1982, report on the same subject. In that report, GAO raised a number of questions about DOE's justification for building a gas centrifuge uranium enrichment plant at Portsmouth, Ohio, at a cost of $7 billion (fiscal year 1983 dollars). The thrust of DOE's comments on GAO's report is that DOE must build the gas centrifuge plant or it will price itself out of the uranium enrichment market. Upon careful analysis of DOE's comments, GAO continues to believe the issues raised in its May 25 report are appropriate for consideration by the Congress. After DOE commented on GAO's report, two events occurred which also bear on the issues discussed in GAO's report and DOE comments. Specifically, DOE accelerated its timetables for developing two advanced enrichment technologies. This supplement, therefore, also briefly discusses DOE's decisions to accelerate these development programs and the technical basis for them.

4422 **(K/OA—5484) Perturbation solution for gas flow in a tapered rotor.** Berger, M.H. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Apr 1983. Contract W-7405-ENG-26. 20p. NTIS, PC A02/MF A01. Order Number DE84002930.

Onsager's equation for the approximate linearized, multidimensional flow in a Gas Centrifuge has been used to construct a new analytical solution for the internal flow in a thermally driven tapered rotor. Our two-dimensional asymptotic approximation exactly satisfies the governing partial differential equation while leaving 0 ($\epsilon^2 y$) residuals in some boundary conditions. It is found that this non-separable solution is characterized by decay towards the top if subjected to a negative wall temperature gradient for a convergent shape and reduces to the usual infinite bowl formula when $\epsilon\ y = 0$. Flow variables of interest like streamfunction and mass velocity are graphically illustrated. 10 references, 8 figures, 1 table.

4423 **(K/OA—5590) Remarks on the axial flow taper in a countercurrent gas centrifuge.** Von Halle, E. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Jun 1983. Contract W-7405-ENG-26. 32p. (CONF-830642—5). NTIS, PC A03/MF A01. Order Number DE84002931.

From 5. international workshop on gases in strong rotation; Charlottesville, VA, USA (6 Jun 1983).

Portions are illegible in microfiche products.

The effect of an axially varying countercurrent circulation rate in a gas centrifuge on the efficiency factors, e/sub I/ (the ideality efficiency) and e/sub C/ (the circulation efficiency), is investigated. The optimum value of the centrifuge parameter, m, which is a measure of the countercurrent circulation rate, is determined as a function of axial position in the centrifuge. Corresponding values of the centrifuge separation efficiency are presented. Numerical examples based on the centrifuge model recommended for use by the Workshop Committee are presented.

4424 **Fiscal year 1984 Department of Energy authorization (Uranium Enrichment and Electric Energy Systems and Storage Programs). Hearings before the Subcommittee on Energy Research and Production of the Committee on Science and Technology, House of Representatives, Ninety-Eighth Congress, First Session, March 10, 17, 1983.** Washington, DC; Government Printing Office (1983). 324p.

Testimony on uranium enrichment activities focused on the importance of the US position as a reliable supplier and DOE's performance in the advanced gas centrifuge and atomic vapor laser isotope separation technologies. The witnesses were William E. Voight, Jr. of DOE and J. Robert Merriman of Oak Ridge, both involved in the uranium enrichment field. The second day's testimony covered research efforts to learn the effects of electro magnetic pulses on electric power systems and new energy storage systems, including dispersed solar for electric vehicles, thermal storage, and superconducting magnetic energy storage. An appendix with additional responses and statements submitted for the record follows each day's testimony. Five witnesses spoke on the second day. (DCK)

4425 **Some fuel cycle implications of metal-based uranium enrichment processes.** Pashley, J.N.; Smith, R.L.; Thomas, J.H. (Union Carbide Corporation, Nuclear Divison, Oak Ridge, Tennessee). *AIChE (American Institute of Chemical Engineers) Symposium Series;* **78**: No. 221, 88-92(1982).

Currently, all production-scale uranium enrichment processes require UF_6 feed and supply UF_6 product to the fuel fabricator. The industries for feed production from the ore concentrate and processing UF_6 product to the required nuclear fuel UO_2 are well established. Although technology for making and handling uranium metal has been utilized on a production scale for many years, significant changes in the fuel cycle would be involved in the deployment of a uranium metal-based separation process. Areas involved include contracting relationships in the utility/converter/DOE infrastructure and potential price changes resulting from the processing flow sheet changes.

4426 **Development of the Plasma Separation Process.** Korn, S.L.; Ridolphi, F. (TRW, Inc. Redondo Beach, California). *AIChE (American Institute of Chemical Engineers) Symposium Series;* **78**: No. 221, 83-87(1982).

The Plasma Separation Process (PSP) is being developed by TRW for the U.S. Department of Energy as part of the Advanced

Isotope Separation (AIS) program for uranium enrichment. The process employs the principle of ion cyclotron resonance to selectively energize the U-235 isotope in a plasma containing U-235 and U-238 ions. Under DOE contract, TRW has assembled integrated test facilities for the development of PSP for uranium enrichment. The latest of these test facilities, capable of demonstrating full process performance, was completed last year and became operational in October 1981. A PSP Development Module Facility, whose conceptual design was recently completed by TRW and Union Carbide Corporation, Nuclear Division, represents the final process scale-up to a production-sized unit.

4427 **Status and plans of the DOE uranium enrichment program.** Voight, W. (United States Dept. of Energy, Washington, DC). *AIChE (American Institute of Chemical Engineers) Symposium Series;* **78**: No. 221, 1-9(1982).

The U.S. Department of Energy has a wide ranging enrichment program. Gaseous diffusion plants have been operated successfully for over three decades and are presently being expanded. A large gas centrifuge plant is under construction and can be fully operational by 1994. An advanced gas centrifuge program promises to achieve substantial improvements, many of which can be incorporated in the plant. Three advanced isotope separation technologies which have potentially low SWU costs are being developed, with selection of one for scale-up scheduled for the near future. These programs are reviewed, and the overall U.S. enrichment strategy is discussed in light of market considerations.

0506 By-products

REFER ALSO TO CITATION(S) 4763

0507 Fuels Production And Properties

REFER ALSO TO CITATION(S) 4484

4428 **Sample handling and transport for the secure automated fabrication line.** Sherrell, D.L.; Genoway, G.G.; Jensen, J.D.; Togesen, H.J. (Westinghouse Electric Corporation, Hanford Engineering Development Laboratory, P.O. Box 1970, Richland, WA 99352). *Transactions of the American Nuclear Society;* **44**: 584-585(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

0508 Spent Fuels Reprocessing

REFER ALSO TO CITATION(S) 4486, 4668, 4673, 4674, 5063, 5089

4429 **(ORNL/TM—8525) Reliability and maintainability data acquisition in equipment development tests.** Haire, M.J.; Gift, E.H. (Oak Ridge National Lab., TN (USA)). Oct 1983. Contract W-7405-ENG-26. 34p. NTIS, PC A03/MF A01. Order Number DE84002994.

The need for collection of reliability, maintainability, and availability data adds a new dimension to the data acquisition requirements of equipment development tests. This report describes the reliability and maintainability data that are considered necessary to ensure that sufficient and high quality data exist for a comprehensive, quantitative evaluation of equipment and system availability. These necessary data are presented as a set of data collection forms. Three data acquisition forms are discussed: an inventory and technical data form, which is filed by the design engineer when the design is finished or the equipment is received; an event report form, which is completed by the senior test operator at each shutdown; and a maintainability report, which is a collaborative effort between senior operators and lead engineers and is completed on restart. In addition, elements of a reliability, maintainability evaluation program are described. Emphasis is placed on the role of data, its storage, and use in such a program.

4430 **Survey of shielding data and methods for fuel reprocessing applications.** Ingersoll, D.T. (Oak Ridge National Laboratory, Oak Ridge, TN 37830). *Transactions of the American Nuclear Society;* **44**: 476-477(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4431 **Radiological controls in a fuel reprocessing operation.** Alexander, D.R. (Exxon Nuclear Idaho Co., Inc., P.O. Box 2800, Idaho Falls, ID 83401). *Transactions of the American Nuclear Society;* **44**: 480-481(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4432 **Human factors in remote control engineering development activities.** Clarke, M.M.; Draper, J.V.; Hamel, W.R. (ORAU). *Transactions of the American Nuclear Society;* **44**: 564-565(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4433 **Totally remote pipe welding system.** Bartilson, B.M.; Doyle, T.E.; Peishel, F.E. (Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH 43201). *Transactions of the American Nuclear Society;* **44**: 574-576(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4434 **Zirconium behaviour in Purex process solutions.** Shu, J. Sao Paulo, Brazil; Instituto de Pesquisas Energeticas e Nucleares (1982). 76p. (In Portuguese). IPEN, Sao Paulo, Brazil.

Thesis (Ph.D.).

The extraction behaviour of zirconium, as fission product, in TBP/diluent- HNO_3-H_2O systems, simulating Purex solutions, is studied. The main purpose is to attain an increase in the zirconium decontamination factor by adjusting the extraction parameters. Equilibrium diagram, TBP concentration, aqueous:organic ratio, salting-out effects and, uranium loading in the organic phase were the main factors studied. All these experiments had been made with zirconium in the 10^{-2} - 10^{-3} concentration range. The extractant degradation products influence upon the zirconium behaviour was also verified. With the obtained data it was possible to introduce some modification in the standard Purex flow-sheet in order to obtain the uranium product with higher zirconium decontamination.

0509 Transport And Storage

REFER ALSO TO CITATION(S) 4478, 4479, 4589, 4680, 4681, 4693, 5096

4435 (ANL/RERTR/TM—4, pp 475-478) **Transport of nuclear material (Part I).** Geiger, H. (Transnuklear GmbH, Hanau, Germany). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The TNF company, a subsidiary of NUKEM and Transnucleaire, is briefly described. The discussion briefly covers regulations and costs involved with transportation of highly enriched uranium fuel and fuel with enrichment less than 20%.

4436 (ANL/RERTR/TM—4, pp 501-513) **Excerpts from: safety analysis report for packaging of TRIGA and MTR irradiated fuel assemblies in MH-1A spent-fuel shipping cask .** Pope, R. (Sandia Labs., Albuquerque, NM). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The MH-1A cask is described as are modifications for transport of TRIGA-type fuels and three typical MTR-type fuels.

4437 (ANL/RERTR/TM—4, pp 514-516) **Nuclear materials transportation at Battelle.** Emswiler, T.R.; Stahl, D. (Battelle, Columbus Labs., OH). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Battelle's nuclear materials transport capabilities are described. Their experience in the transport of spent research reactor fuels in the BMI-1 cask is discussed.

4438 (UCRL—53294-82) **Spent Fuel Test - Climax: technical measurements. Interim report, fiscal year 1982.** Patrick, W.C.; Ballou, L.B.; Butkovich, T.R.; Carlson, R.C.; Durham, W.B.; Hage, G.L.; Majer, E.L.; Montan, D.N.; Nyholm, R.A.; Rector, N.L. (Lawrence Livermore National Lab., CA (USA)). Feb 1983. Contract W-7405-ENG-48. 123p. NTIS, PC A06/MF A01. Order Number DE84003336.

The Spent Fuel Test - Climax (SFT-C) is located 420 m below surface in the Climax stock granite on the Nevada Test Site. The test is being conducted for the US Department of Energy (DOE) under the technical direction of the Lawrence Livermore National Laboratory (LLNL). Eleven canisters of spent nuclear reactor fuel were emplaced, and six electrical simulators were energized April to May 1980, thus initiating a test with a planned 3- to 5-year fuel storage phase. The SFT-C operational objective of demonstrating the feasibility of packaging, transporting, storing, and retrieving highly radioactive fuel assemblies in a safe and reliable manner has been met. Three exchanges of spent fuel between the SFT-C and a surface storage facility furthered this demonstration. Technical objectives of the test led to development of a technical measurements program, which is the subject of this and two previous interim reports. Geotechnical, seismological, and test status data have been recorded on a continuing basis for the first 2-1/2 years of the test on more than 900 channels. Data continue to be acquired from the test. Some data are now available for analysis and are presented here. Highlights of activities this year include analysis of fracture data obtained during site characterization, laboratory studies of radiation effects and drilling damage in Climax granite, improved calculations of near-field heat transfer and thermomechanical response, a ventilation effects study, and further development of the data acquisition and management systems.

4439 **The NRC program for inspection and enforcement of nuclear transportation.** Grella, A.W. (U.S. Nuclear Regulatory Commission, Washington, DC 20555). *Transactions of the American Nuclear Society;* **44**: 479(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4440 **Duke Power spent fuel storage and transportation experience.** Rasmussen, R.W.; Frech, D.F.; Snead, H.T. (Duke Power Company, P.O. Box 33189, Charlotte, NC 28242). *Transactions of the American Nuclear Society;* **44**: 479-480(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

0510 Marketing And Economics

REFER ALSO TO CITATION(S) 4444

0520 Waste Management

REFER ALSO TO CITATION(S) 4439, 4481, 4482, 4483, 4582, 4619, 4668, 5024, 5038, 5040, 5377, 5438

4441 (BNL-NUREG—33777) **Properties and solidification of decontamination wastes.** Davis, M.S.; Piciulo, P.L.; Bowerman, B.S.; Adams, J.W.; Milian, L. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 13p. (CONF-8308106—24). NTIS, PC A02/MF A01 - GPO. Order Number DE84002878.

From 5. annual participants information meeting of DOE low level waste management program; Denver, CO, USA (30 Aug 1983).

LWRs will require one or more chemical decontaminations to achieve their designed lifetimes. Primary system decontamination is designed to lower radiation fields in areas where plant maintenance personnel must work. Chemical decontamination methods are either hard (concentrated chemicals, approximately 5 to 25 weight percent) or soft (dilute chemicals less than 1 percent by weight). These methods may have different chemical reagents, some tailormade to the crud composition and many methods are and will be proprietary. One factor common to most commercially available processes is the presence of organic acids and chelates. These types of organic reagents are known to enhance the migration of radionuclides after disposal in a shallow land burial site. The NRC sponsors two programs at Brookhaven National Laboratory that are concerned with the management of decontamination wastes which will be generated by the full system decontamination of LWRs. These two programs focus on potential methods for degrading or converting decontamination wastes to more acceptable forms prior to disposal and the impact of disposing of solidified decontamination wastes. The results of the solidification of simulated decontamination resin wastes will be presented. Recent results on combustion of simulated decontamintion wastes will be described and procedures for evaluating the release of decontamination reagents from solidified wastes will be summarized.

4442 (CONF-831174—21) **Partitioning of cesium in hydrofracture grouts.** Stinton, D.P.; McDaniel, E.W.; Weeren, H.O. (Oak Ridge National Lab., TN (USA)). 31 Aug 1983. Contract W-7405-ENG-26. 16p. NTIS, PC A02/MF A01. Order Number DE84003397.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

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Phase characterization of hydrofracture grouts was accomplished with the use of optical microscopy, scanning electron microscopy, x-ray diffraction, and β-γ autoradiography. A laboratory-produced sample containing 1 wt % stable cesium and an actual hydrofracture grout sheet obtained by core dirlling were examined during this work. The phases present in these samples were identified and cesium was found to be absorbed almost entirely by illite clay agglomerates. These clay agglomerates were tightly bound within the grout structure by hydrated calcium silicates. The β-γ autoradiography of the core-drilled sample verified that cesium and other radionuclides were trapped within the 20-year-old grout and had not migrated into trapped shale fragments. 14 references, 3 figures, 1 table.

4443 (CONF-8311105—3) **Management of defense beta-gamma contaminated solid low-level wastes.** Sease, J.D. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01. Order Number DE84003391.

From DOE/CEA meeting on defense waste management; Knoxville, TN, USA (9 Nov 1983).

In DOE defense operations, ~ 70,000 m^3 of beta-gamma low-level radioactive waste are disposed of annually by shallow land burial operations at six primary sites. Waste generated at other DOE sites are transported on public roads to the primary sites for disposal. In the practice of low-level waste (LLW) disposal in the US, the site hydrology and geology are the primary barriers to radioactive migration. To date, little emphasis has been placed on waste form improvements or engineered site modifications to reduce migration potential. Compaction is the most common treatment step employed. The performance of ground disposal of radioactive waste in this country, in spite of many practices that we would consider unacceptable in today's light, has resulted in very little migration of radioactivity outside site boundaries. Most problems with previously used burial grounds have been from subsidence at the arid sites and subsidence and groundwater contact at the humid sites. The radionuclides that have shown the most significant migration are tritium, ^{90}Sr, and ^{99}Tc. The unit cost for disposal operations at a given DOE site is dependent on many variables, but the annual volume to be disposed is probably the major

factor. The average cost for current DOE burial operation is approximately $170/m³. 23 figures.

4444 **(DOE/LLW—25T) Economics model for new low-level radioactive waste disposal sites.** (EG and G Idaho, Inc., Idaho Falls (USA)). Dec 1983. Contract AC07-76ID01570. 49p. NTIS, PC A03/MF A01. Order Number DE84003853.

This report describes LLWECON, an interactive computer mode for evaluating financial factors involved in low-level radioactive waste disposal. The logic by which LLWECON calculates the final generator price (price per cubic foot the disposal site operator charges waste generators) is detailed. Required user input and hypothetical examples, covering sites with different capacities, and both public and private-sector development, are included.

4445 **(DOE/SR—0011) Defense Waste Processing Facility, Savannah River Plant.** (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Management Systems Labs.). [nd]. Contract AS05-83DP48013. 16p. NTIS, PC A02/MF A01. Order Number DE84002238.

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After 10 years of research, development, and testing, the US Department of Energy is building a new facility which will prepare high-level radioactive waste for permanent disposal. The Defense Waste Processing Facility, known as the DWPF, will be the first production-scale facility of its kind in the United States. In the DWPF, high-level waste produced by defense activities at the Savannah River Plant will be processed into a solid form, borosilicate glass, suitable for permanent off-site geologic disposal. With construction beginning in the fall of 1983, the DWPT is scheduled to be operational in 1989. By 2005, the DWPF will have immobilized the backlog of high-level waste which has been accumulating in storage tanks at the Savannah River Plant since 1954. Canisters of the immobilized waste will then be ready for permanent disposal deep under the ground, safely isolated from the environment.

4446 **(DP-MS—83-72) Longevity of borehole and shaft sealing materials: characterization of ancient cement based building materials.** Langton, C.A.; Roy, D.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.; Pennsylvania State Univ., University Park (USA). Materials Research Lab.). 1983. Contract AC09-76SR00001. 8p. (CONF-831174—16). NTIS, PC A02/MF A01. Order Number DE84003031.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Durability and long-term stability of cements in plasters, mortars, and/or concretes utilized as borehole plugging and shaft sealing materials are of present concern in the national effort to isolate nuclear waste within deep geological repositories. The present study consists of an examination of selected ancient building materials and provides insights into the durability of certain ancient structures. These data were combined with knowledge obtained from the behavior of modern portland cements and natural materials to evaluate the potential for longevity of such materials in a borehold environment. Analyses were conducted by petrographic, SEM, chemical, and x-ray diffraction techniques. 7 references, 5 figures, 2 tables.

4447 **(DP-MS—83-114) Tritium waste disposal technology in the US.** Albenesius, E.L.; Towler, O.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1983. Contract AC09-76SR00001. 20p. (CONF-8311105—2). NTIS, PC A02/MF A01. Order Number DE84002620.

From DOE/CEA meeting on defense waste management; Knoxville, TN, USA (9 Nov 1983).

Tritium waste disposal methods in the US range from disposal of low specific activity waste along with other low-level waste in shallow land burial facilities, to disposal of kilocurie amounts in specially designed triple containers in 65' deep augered holes located in an aird region of the US. Total estimated curies disposed of are 500,000 in commercial burial sites and 10 million curies in defense related sites. At three disposal sites in humid areas, tritium has migrated into the ground water, and at one arid site tritium vapor has been detected emerging from the soil above the disposal area. Leaching tests on tritium containing waste show that tritium in the form of HTO leaches readily from most waste forms, but that leaching rates of tritiated water into polymer impregnated concrete are reduced by as much as a factor of ten. Tests on improved tritium containment are ongoing. Disposal costs for tritium waste are 7 to 10 dollars per cubic foot for shallow land burial of low specific activity tritium waste, and 10 to 20 dollars per cubic foot for disposal of high specific activity waste. The cost of packaging the high specific activity waste is 150 to 300 dollars per cubic foot. 18 references.

4448 **(DPST—80-110-6) TNX full-scale continuous melter startup technical guide and procedure.** Willis, T.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 24 Jul 1980. Contract AC09-76SR00001. 40p. NTIS, PC A03/MF A01. Order Number DE84003689.

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The full-scale TNX cylindrical melter will be started up and subsequently operated with calcine feed. The startup method will be by heatup of the melter to 900°C temperature with a propane burner, followed by heatup to operating temperature (1150°C) by joule heating. Details for the startup are given.

4449 **(LBL—16795) Geologic disposal of radioactive waste, 1983.** Pigford, T.H. (Lawrence Berkeley Lab., CA (USA)). Oct 1983. Contract AC03-76SF00098. 44p. (CONF-831063—9). NTIS, PC A03/MF A01. Order Number DE84002890.

From American Institute of Chemical Engineers fall annual meeting; Washington, DC, USA (30 Oct 1983).

Geologic repositories for radioactive waste are evolving from conceptualization to the development of specific designs. Estimates of long-term hazards must be based upon quantitative predictions of environmental releases over time periods of hundreds of thousands of years and longer. This paper summarizes new techniques for predicting the long-term performance of repositories, it presents estimates of future environmental releases and radiation doses that may result for conceptual repositories in various geologic media, and it compares these predictions with an individual dose criterion of 10^{-4} Sv/y. 50 references, 11 figures, 6 tables.

4450 **(ORNL/Sub—83-1012/3) Experimental determination of the solubilities of dissolver off-gas constituents in a Kr-85 recovery solvent (CCl_2F_2). Final report.** van Brunt, V. (South Carolina Univ., Columbia (USA). Coll. of Engineering). May 1983. Contract AS05-77SR01012. 47p. NTIS, PC A03/MF A01. Order Number DE84002961.

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The experimental determination of the solubility of the major off-gas constituent-Nitrogen was performed with a new solubility measurement apparatus. The new apparatus was designed, built and tested; an algorithm for thermodynamic consistency testing of P-T-x-y data for solubility systems was developed, and thermodyı•mically consistent Nitrogen-R-12 solubility data were taken. The Henry's Law constant for the Nitrogen-R-12 system can be represented by the equation ln H/sub N_2-R-12/ (atm) = 0.44 + 1.0708 lnT (°K). The solubility data extend the range of known equilibrium data into a region where process equipment operate and are consistent with both other data at lower temperatures by other researchers and with regular solution theory.

4451 **(PNL-SA—11103) Low-level radioactive waste consolidation program.** Tanner, J.E.; Murphy, B.L.; Stein, S.L.; Lyso, O.M.; Gilchrist, R.L. (Pacific Northwest Lab., Richland, WA (USA)). Jan 1983. Contract AC06-76RL01830. 11p. (CONF-830695—9). NTIS, PC A02/MF A01. Order Number DE84003349.

From Health Physics Society annual meeting; Baltimore, MD, USA (19 Jun 1983).

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The objective of the program was to determine the requirements and feasibility of a centralized facility to consolidate low-level radioactive wastes for a sponsor who had a large number of small generators scattered throughout the country. This facility was to be designed to reduce the volume of low-level waste requiring

disposal and would ensure that the final waste form and package would meet transportation and burial site requirements. While a case study was used to develop the low-level waste consolidation program described, the general principles used to develop the program could be applied to any group of low-volume generators in the same geographical area or waste compact region, for example, universities, hospitals, or research facilities. Two conclusions were made. The first is that a consolidation facility is well within the design capabilities of current available technology. All the volume reduction equipment has been tested and operated by various research institutions and private industry. Secondly, using the volume reduction techniques described in this report, a consolidation facility is economically feasible given a large enough quantity of waste. Finally, although for the case studied it was shown that a low-level waste consolidation facility of the type described would have minimal environmental impact due to the nature of the materials and processing techniques, the environmental impacts would have to be assessed for other applications.

4452 **(PNL-SA—11415) Gamma radiolysis effects on basalt groundwater.** Gray, W.J. (Pacific Northwest Lab., Richland, WA (USA)). Oct 1983. Contract AC06-76RL01830. 11p. (CONF-831174—33). NTIS, PC A02/MF A01. Order Number DE84003598.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Gamma radiolysis of basalt groundwater containing 700 ppM methane produces a milky liquid that is a suspension of fine particles of a high molecular weight hydrocarbon somewhat like polyethylene. The ability of these polymers to chelate with, or otherwise sorb, metal ions from aqueous solution was measured using Cu^{+2} as a representative cation. Values in the range 0.3 to 0.8 millimoles of Cu per liter of solution were found. 5 references, 2 figures, 2 tables.

4453 **(PNL-SA—11465) Glass reactivity in aqueous solutions.** Baer, D.R.; Pederson, L.R.; McVay, G.L. (Pacific Northwest Lab., Richland, WA (USA)). Sep 1983. Contract AC06-76RL01830. 19p. (CONF-831171—14). NTIS, PC A02/MF A01. Order Number DE84003347.

From American Vacuum Society meeting; Boston, MA, USA (1 Nov 1983).

Surface analysis methods have been incorporated as part of several studies concerning the mechanisms and amount of glass leaching in aqueous solutions. The reactivity of simple glasses with water has been determined by measuring the uptake of D and ^{18}O in soda lime silicate glass, amorphous and crystalline silica, and amorphous and crystalline albite leached in D_2 ^{18}O at 90°C as a function of time. The concentrations and profiles of ^{18}O and D going into the glass were determined using nuclear reaction analysis and compared to the material leached from the glass as determined by solution and Rutherford backscattering (RBS) analyses. The measured ratio of $D/^{18}O$ does not follow any one simple uptake model. Reaction layers formed on simulated nuclear waste glasses containing Pu have also been measured using RBS. Specimens were leached in deionized water or brine at 90°C. The concentration of Pu on the specimens generally decreased with time. Analysis of the leaching solution indicated that the rate of Pu release was considerably less than that of the glass matrix. The results support the build-up of a surface layer covering the Pu.

4454 **(PNL-SA—11770) Evaluation of a spent fuel as a waste form in a salt repository.** Gray, W.J.; McVay, G.L.; Barner, J.O.; Shade, J.W.; Cote, R.W. (Pacific Northwest Lab., Richland, WA (USA); Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Oct 1983. Contract AC06-76RL01830. 15p. (CONF-831174—25). NTIS, PC A02/MF A01. Order Number DE84003343.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Leach tests have been performed on spent fuel in sythetic Permian Basin salt brine at 25 and 75°C. Complementary tests on unirradiated UO_2 peilets have been conducted in both salt brine and deionized water in the range 25 to 150°C. Iron and/or oxidized zircaloy coupons were included in some of the tests. Uranium release from spent fuel was more than 100 times greater than from UO_2. In brine, iron had no significant effect on the total uranium release but substantially reduced the amount in solution by causing the uranium to plate out on the iron coupon and container walls and to precipitate as filterable particles.

4455 **(RFP—3533) Waste systems. Progress report, January 1982-February 1983.** Hickle, G.L. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 24 Oct 1983. Contract AC04-76DP03533. 21p. NTIS, PC A02/MF A01. Order Number DE84002131.

A laboratory-scale beryllium electrorefining cell has been placed in operation and metallic beryllium with a purity greater than 99.95% has been produced. Methods of uranium chip disposal have been evaluated by performing bench- and pilot-scale testing and by surveying present chip disposal methods. A design criteria has been completed for a new production uranium chip disposal facility. Two types of cementation immobilization processes are being developed to treat several Rocky Flats wastes which do not currently meet repository acceptance criteria. The nitrate salts, as now shipped, are an extremely fine powder, composed chiefly of sodium and potassium nitrate. Nitrates are an oxidizer, and their behavior in a possible fire would be of concern. Accident caused fires involving a cargo of boxed nitrate salts were modeled and the burning characteristics noted. In addition, gypsum cement was tested as an immobilization matrix to reduce dispersibility. A program is in process to construct a facility to remotely size reduce gloveboxes and miscellaneous equipment contaminated with plutonium and other radioactive nuclides. The Title II engineering package is completed and the construction of the facility has been initiated. Modification and additions to the 82 kg/h Fluidized Bed Incinerator were made in preparation for turning the unit over to Production. A program was initiated to identify, characterize, and evaluate for recycle all the spent oil and solvent streams which are immobilized and disposed as Transuranic (TRU) waste. Three technologies were evaluted for denitrification method was studied at Rocky Flats while a thermal decomposition process and a molten salt chemical conversion technique were investigated on a subcontract basis with Thagard Research Corporation and Rockwell International, Energy Systems Group, respectively.

4456 **(SAND—83-1695C) Review of science and technology for disposal of low-level waste on the seabed and high-level waste in the subseabed.** Anderson, D.R.; Boyer, D.G.; Hollister, C.D. (Sandia National Labs., Albuquerque, NM (USA); USDOE Albuquerque Operations Office, NM; Woods Hole Oceanographic Institution, MA (USA)). 1983. Contract AC04-76DP00789. 68p. (CONF-830934—1). NTIS, PC A04/MF A01. Order Number DE84003253.

From 4. Pacific Basin nuclear conference; Vancouver, Canada (11 Sep 1983).

In 1980 it was recommended that an effort be made to increase the scientific data base relating to the oceanographic and biological characteristic of the Northeast Atlantic dumping area. The overall safety of sea dumping operations depends on a number of factors such as the characteristics of the dumping site, the amount, composition, conditioning, and packaging of waste, and the way in which operations are organized and controlled. An NEA research and environmental surveillance program related to sea disposal of low-level radioactive waste (LLW) is proceeding. Information from these studies will apply to disposal of LLW such as reactors from nuclear submarines and contaminated soil, as well as to packaged LLW. In Sweden, construction has begun on a repository located in the granitic rock beneath the seabed. The feasibility of a concept of burying high-level radioactive waste within the geologically stable formations of the deep ocean floor is being assessed. These subseabed options for a waste repository are being considered for several reasons. The granitic rock selected for the Swedish repository has a low hydraulic gradient, thereby reducing the amount of radioactivity tht will diffuse out of the repository. The sea water that covers the repository will dilute and disperse any radioisotopes that do escape from the repository. The other nations studying the feasibility of a subseabed repository are examining the fine-grained clay formations within the stable, predictable deep-sea regions, away from the boundaries of the lithospheric plates and productive surface waters. This clay has properties that may serve to permanently isolate radioactive waste. The most important characteristics of such clays are their vertical and lateral uniformity,

low permeability, very high cation retention capacity, and potential for self-healing when disturbed.

4457 **(UCRL—89404-Rev.1) Selection of barrier metals for a waste package in tuff.** Russell, E.W.; McCright, R.D.; O'Neal, W.C. (Lawrence Livermore National Lab., CA (USA)). Oct 1983. Contract W-7405-ENG-48. 12p. (CONF-831174—3-Rev.1). NTIS, PC A02/MF A01. Order Number DE84003004.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

The Nevada Nuclear Waste Storage Investigations (NNWSI) project under the Civilian Radioactive Waste Management Program is planning a repository at Yucca Mountain at the Nevada Test Site for isolation of high-level nuclear waste. Lawrence Livermore National Laboratory is developing designs for an engineered barrier system containing several barriers such as the waste form, a canister and/or an overpack, packing, and near field host rock. In this paper we address the selection of metal containment barriers. 13 references, 4 tables.

4458 **(UNI-SA—118) DOE decontamination and decommissioning program experiences.** Dabrowski, T.E. (UNC Nuclear Industries, Inc., Richland, WA (USA). Decommissioning Programs Dept.). 1983. Contract AC06-76RL01857. 28p. (CONF-8311105—1). NTIS, PC A03/MF A01. Order Number DE84002337.

From DOE/CEA meeting on defense waste management; Knoxville, TN, USA (9 Nov 1983).

Approximately 475 United States government-owned facilities used in national defense and energy development programs have been shutdown and declared excess to present needs. These facilities include nuclear reactors, fuel reprocessing plants, waste treatment systems, laboratory facilities, and liquid and solid waste disposal grounds. Many of the facilities contain large quantities of man-made radioactive materials. Some of the facilities were constructed in the early 1940's, and have been deteriorating since their shutdown up to 20 years ago. Maintenance of these facilities has been performed to assure adequate control of the radioactive materials, however, this work has been expensive. None of these surplus facilities were designed to be long-term waste repositories, therefore, final decommissioning must be performed. In many instances, decommissioning work can make serviceable facilities, equipment, or materials available for other government uses. In other cases, the contamination can be fixed and the facility sealed to prevent intrusion or spread of radioactive material. In some instances, it may be most cost effective to dismantle the facility and release the land for other uses or for sale. This paper presents a general overview of the DOE program for decommissioning of surplus facilities and provides specific information of five typical decommissioning projects that are currently underway. These projects involve work on a plutonium laboratory, a liquid waste handling system, two hot cell facilities, and a large production reactor. Decommissioning techniques, equipment and results of actual field experiences will be described. 2 figures, 1 table.

4459 **Beneficial uses of nuclear waste.** (U.S. Department of Energy, Washington, DC 20545). *Transactions of the American Nuclear Society;* **44**: 400-401(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4460 **Evaluation of a shredder/compactor for DAW treatment.** Dunn, M.J.; Vance, J.N. (EDS Nuclear Inc., 330 Technology Park/Atlanta, Norcross, GA 30092). *Transactions of the American Nuclear Society;* **44**: 433-434(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4461 **Incineration of ion-exchange resins using a cocentric burner.** Chino, K.; Fukasawa, T.; Kawamura, F.; Kuriyama, O.; Yusa, H. (Hitachi Ltd., Energy Research Laboratory, 1168 Moriyama-cho, Hitachi-shi, Ibaraki, 316). *Transactions of the American Nuclear Society;* **44**: 434-435(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4462 **Recent experience: processing radioactive steam generator decontamination grit for disposal.** DiSalvo, R.; McCauley, M. (Hittman Nuclear and Development Corporation, 9190 Red Branch Road, Columbia, MD 21045). *Transactions of the American Nuclear Society;* **44**: 435-436(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4463 **Development of an electrolytic decontamination technique using a dilute sulfuric acid electrolyte.** Miyakawa, M.; Hasegawa, Y.; Kaneda, H.; Kikuchi, A.; Takeuchi, M. (Chubu Electric Power Company, Higashi-shinmachi, Higashi-ku, Nagoya, 461-91). *Transactions of the American Nuclear Society;* **44**: 436-438(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4464 **Use of fluidized-bed technology for low-level waste management.** Garcia, R.; Spas, S.E. (Aerojet Energy Conversion Co., P.O. Box 13222, Sacramento, CA 95813). *Transactions of the American Nuclear Society;* **44**: 438-439(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4465 **Dynamic simulation of radwaste evaporator systems.** Amin, H.; Chiu, K.C.; James, D. (Bechtel National, Inc., P.O. Box 3965, San Francisco, CA 94119). *Transactions of the American Nuclear Society;* **44**: 467-469(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4466 **Evaluation of radiation source terms for the components of a radwaste volume reduction and solidification system.** Yeh, C.S.; Tuohy, J.M. (Burns & Roe, Inc., 650 Winters Avenue, Paramus, NJ 07675). *Transactions of the American Nuclear Society;* **44**: 477-478(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4467 **High-activity waste handling at Vallecitos.** Butler, R.E.; Hall, T.C. (General Electric Co., P.O. Box 460 Pleasanton, CA 94566). *Transactions of the American Nuclear Society;* **44**: 586-587(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4468 **Remote maintenance techniques in a radioactive vitrification plant.** Selig, M. (Kernforschungszentrum Karlsruhe, Postfach 3640, D-7500 Karlsruhe 1). *Transactions of the American Nuclear Society;* **44**: 587-589(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4469 **Grapple system for remotely handled waste packages and components.** Reynolds, R.K.; Gellatly, R.K. (Raymond Kaiser Engineers, P.O. Box 23210, BB-4 Oakland, CA 94623). *Transactions of the American Nuclear Society;* **44**: 589-590(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4470 **The Whiteshell Nuclear Research Establishment immobilized fuel test facility.** Ryz, M.A. (Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba R0E 1L0). *Transactions of the American Nuclear Society;* **44**: 590-591(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4471 **Mockup and test support for design of a remote analytical laboratory.** Ross, M.J. (Exxon Nuclear Idaho Co., Inc., P.O. Box 2800, Idaho Falls, ID 83401). *Transactions of the American Nuclear Society;* **44**: 591-592(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4472 **Numerical analysis of burial ground geography.** Fields, D.E.; Glandon, S.A.; Little, C.A. (Oak Ridge National Lab., TN). *Health Physics;* **44**: No. 6, 655-658(Jun 1983). Contract W-7405-ENG-26.

The MAGIC (Map Analysis and Graphic Interpretation Code) program used to analyze survey plots of the shallow burial ground for radionuclide waste disposal at Barnwell, South Carolina is described. Determinations have been made of the total surface area of burial trenches and the mean distance from trench areas to an identified aquifer surface seepage point located approx. 1 km distant from the burial area. The procedure required very little operator time and updates of the grapical information allow the computation of future configurations of burial areas at this site. (JMT)

4473 **Chemical durability of Savannah River Plant waste glass as a function of waste loading.** Rankin, W.D.; Wicks, G.G. (E. I. du Pont de Nemours & Co., Inc., Savannah River Laboratory, Aiken, South Carolina 29808). *Journal of the American Ceramic Society;* **66**: No. 6, 417-420(Jun 1983). Contract AC09-76SR00001.

The leachability of Savannah River Plant (SRP) waste forms was assessed for glass containing up to 50 wt% simulated waste oxides. Leach tests included standard MCC-1 static tests and pH-buffered solution experiments. An integrated approach combining leachate solution analysis with both bulk and surface analyses was used to study waste-glass corrosion as a function of waste loading. Scouting tests on key processing and product parameters, such as viscosity, electrical resistivity, and density were also performed. Results of this study show that the durability of SRP waste glass improves due to the presence of the waste, for waste loadings up to 50 wt% because of the formation of protective surface layers. In addition, the data indicate that the practical limit of waste loading will be determined not by chemical durability of the product, but by processing considerations.

4474 **Dissolution of a nuclear waste ceramic: an experimental and modeling study.** Ryerson, F.J.; Bazan, F.; Campbell, J.H. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of the American Ceramic Society;* **66**: No. 6, 462-470(Jun 1983). Contract W-7405-ENG-48.

The degree of alteration of a multiphase ceramic waste form (Synroc-D) exposed to flowing water at 75°C is reported. After 117 days, a 25- to 30-μ-deep leach zone developed from which all silicate phases have congruently dissolved. The associated spinel and titanate phases appear unaltered, whereas an $Al(OH)_3$ precipitate $\approx$ 5-μm-thick develops at the sample surface. The dissolution of silicates and deposition of the precipitate are simulated using a modification of the crackling-core model. The model predictions closely match the observed behavior of the material. Implications of these results for long-term stability of the waste form are discussed.

4475 **The transfer of technology on radioactive waste disposal - The Argentine experience.** Gonzalez, A.J.; Migliori de Beninson, A. (CNEA/Argentina, Comision Nacional de Energia Atomica, Av. Del Libertador 8250, 1429, Buenos Aires). *Transactions of the American Nuclear Society;* **42**: 92-93(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4476 **Consideration of technology transfer in the problem of low-level waste management.** Mergan, L. (BELGATOM/Belgium, BELGATOM S.A., 75 rue de la roi, B-1040, Brussels). *Transactions of the American Nuclear Society;* **42**: 93-94(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nóv 1982).

4477 **Technology transfer in waste management.** Flowers, R.H. (United Kingdom Atomic Energy Authority, Culcheth, Warrington WA3 4NE). *Transactions of the American Nuclear Society;* **42**: 94-97(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4478 **The direct disposal of spent fuel elements - a technical and economic alternative to reprocessing.** Bienek; H.; Weinhold, G.; Wick, W. (STEAG Kernenergie GmbH, Bismarckstr. 54, 4300, Essen 1). *Transactions of the American Nuclear Society;* **42**: 97-98(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4479 **Description of the fuel element storage and interim storage for low-level radioactive wastes in Gorleben.** Hannover, Germany, F.r.; Deutsche Gesellschaft fuer Wiederaufarbeitung von Kernbrennstoffen m.b.H. (DWK) (1982). 22p. (In German). Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

Concept presentation and safety aspects of the dry storage (Castor-containment) for spent FEs and of the interim storage for LAWs.

4480 **National program for immobilization of high-level radioactive wastes.** Gordon, D.E.; Bernadzikowski, T.A. (E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC 29808). *American Society of Mechanical Engineers, [Paper];* No. 82-NE-34, 10(1982). (CONF-820705—). Contract AC09-76SR00001.

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

The Department of Energy (DOE) has developed a national plan for isolating U.S. nuclear wastes from the human environment. As part of this plan, a program to develop the technology for the immobilization of high-level radioactive wastes generated from reprocessing of spent reactor fuels from both defense and commercial sources is being managed by a DOE lead office at Savannah River. Seven candidate waste forms for immobilization and geologic disposal of high-level wastes were compared on the bases of waste-specific evaluations, peer review recommendations, a product performance evaluation, and a processability analysis. Two of the forms, borosilicate glass and a crystalline ceramic, were selected for continued development as the reference and alternative forms, respectively.

0530 Environmental Aspects

REFER ALSO TO CITATION(S) 4442, 4449, 4453, 5386, 5433

4481 **(BNL-NUREG—33580) Wet and dry cycle leaching: aspects of releases in the unsaturated zone.** Dayal, R.; Davis, R.E.; Schweitzer, D.G. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 13p. (CONF-8308126—3). NTIS, PC A02/MF A01 - GPO. Order Number DE84002853.

From NRC research annual review meeting of nuclear waste management research on geochemistry of HLW disposal; Reston, VA, USA (30 Aug 1983).

The NRC criteria of containment and controlled release for a HLW repository have in the past been addressed by leaching and radionuclide release experiments that correspond to repository flooding or temporally independent saturation. Both high-level waste repository and low-level waste burial sites can be expected to experience unsaturated conditions, as determined by the nature, frequency, and length of the wetting fronts. An important aspect of radionuclide release in the unsaturated zone is the effect of cyclic wet/dry leaching conditions. In this paper we have considered aspects of radionuclide release from low-level waste form subjected to wet/dry cycles, simulating burial in the unsaturated zone. Some preliminary results of cesium and strontium release are presented, showing that the processes occurring during the unsaturated period of the wet/dry cycle can have a profound effect on the overall release of radionuclides.

4482 **(CONF-831025—26) Analytical measurements of actinide migration in a laboratory-simulated basalt HLW repository.** Bowers, D.L.; Gerding, T.J.; Fried, S.M.; Vandegrift, G.F.; Seitz, M.G. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 9p. NTIS, PC A02/MF A01. Order Number DE84003717.

From 26. ORNL-DOE conference on analytical chemistry in energy technology; Knoxville, TN, USA (11 Oct 1983).

Described are the analytical methods and results used to determine the migration of actinides in a flowing-groundwater laboratory-simulation of a basalt repository for high-level nuclear waste. The radiochemical methods developed and employed to measure actinide activities in groundwater samples and component surfaces include the use of gamma, X-rays, and alpha spectroscopy, with associated preparation and calibration. These methods include double isotope spiking with Np-235 and Pu-236 for determination of Np-237 and Pu-239 in groundwater, gamma-spectroscopic measurements of rock surfaces for spatially profiling neptunium activity, and a leaching procedure for quantitating the actinide activities on those rock surfaces.

4483 **(LA-UR—83-3385) Influence of soil biopopulation on migration of waste radionuclides.** Fowler, E.B.; Polzer, W.L.; Essington, E.H. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 9p. (CONF-8310157—3). NTIS, PC A02/MF A01. Order Number DE84003835.

From 29. annual conference on bioassay, analytical and environmental chemistry; Seattle, WA, USA (12 Oct 1983).

This paper reports the interpretation of some results obtained when a Maxey Flats burial pit radioactive waste solution was reacted with a Tilsit soil. The influence of a biopopulation on the degree of sorption and on the stability of that system was investigated. The data have been interpreted as follows: the removal of ^{137}Cs from solution by the soil is essentially complete within a one-hour period and is not influenced by an active biopopulation. The soil studied contains complexers which solublize ^{238}Pu. The soluble complex does not sorb to soil and thus is potentially mobile. In the presence of an active biopopulation 86% of the complexes is degraded; the released ^{238}Pu was rendered immobile. The remaining 14% of the soluble ^{238}Pu was not released to the soil during 53 days incubation. That fraction is heat stable and non- or slowly-biodegradable and thus retains its potential to migrate.

0540 Health And Safety

REFER ALSO TO CITATION(S) 4430, 4431, 4449, 4458, 4466, 4479, 5369, 5410, 5412, 5413, 5414, 5415, 5416, 5417, 5420, 5421

4484 **Study of the influence of multiple recycling of plutonium on the problems of radiation protection in a plant for production of mixed oxide fuel.** Hanau, Germany, F.R.; Alpha Chemie und Metallurgie G.M.B.H., (ALKEM) ([nd]). 77p. (In German). Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

The measuring results globally show the expected increase of the dose rate of recycled Pu of the given composition as against the Pu of the 1st generation and the great dependence of the measuring data upon factors like quantity, degree of dilution, distance and impurities (e.g. Am). Without special shieldings it is in all cases the γ-radiation that provides the major part of the total exposure at a gamma/neutron radiation ratio of up to 40:1. With the usual shielding at the outside of the glove boxes this relation varies towards an equivalent or even greater contribution of the neutron radiation to the total dose. The neutrons will have to be particularly taken into account mainly in the fields of fabrication where large amounts of pure PuO_2 are handled. A sufficient shielding seems to be absolutely feasible even in these fields. In case the shielding measures have to be completed to the extent absolutely required for operation, in order to obtain an appropriate local dose rate right next to the box by reducing the emission rates, i.e. by limiting the processing quantity. It is also remarkable that the results show a considerable influence of the Am-impurity upon the γ-source strength and the γ-rate. Therefore it will still be necessary, especially with exclusive processing of Pu from high-radioactive spent fuel and of recycled Pu, to separate as far as possible the Am before processing and to keep the degree of contamination of the glove boxes as low as possible.

0550 Regulations

REFER ALSO TO CITATION(S) 4421, 4782

4485 **(GAO/RCED—83-143) Data on DOE's Uranium Enrichment Program.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 15 Apr 1983. 9p. US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20760.

This letter contains the answers to the following questions: What were DOE's expenditures for uranium enrichment research and development and pilot plant operations from 1970 to the present; What were DOE's expenditures for enrichment-related construction from 1970 to the present; What was the depreciation component of DOE's enrichment services price from 1970 to the present; and What are DOE's plans for recovering projected enrichment capital investments over the next 20 years. Questions dealing with the price TVA charges DOE for its electric power will be provided at a later date.

4486 **(LA—9820-M) Solution assay instrument operations manual.** Li, T.K.; Marks, T.; Parker, J.L. (Los Alamos National Lab., NM (USA)). Sep 1983. Contract W-7405-ENG-36. 50p. NTIS, PC A03/MF A01. Order Number DE84003561.

An at-line solution assay instrument (SAI) has been developed and installed in a plutonium purification and americium recovery process area in the Los Alamos Plutonium Processing Facility. The instrument was designed for accurate, timely, and simultaneous nondestructive analysis of plutonium and americium in process solutions that have a wide range of concentrations and americium/plutonium ratios and for routine operation by process technicians who lack instrumentation background. The SAI, based on transmission-corrected, high-resolution gamma-ray spectroscopy, has two measurement stations attached to a single multichannel analyzer/computer system. To ensure the quality of assay results, the SAI has an internal measurement control program, which requires daily and weekly check runs and monitors key aspects of all assay runs. For a 25-ml sample, the assay precision is $< 1\%$, both for plutonium and for americium having concentrations > 5 g/l within a 2000-s count time.

4487 **(LA-UR—83-3381) Measurements of uranium holdup in an operating gaseous diffusion enrichment plant.** Augustson, R.H.; Walton, R.B.; Harris, R.; Harbarger, W.; Hicks, J.; Timmons, G.; Shissler, D.; Tayloe, R.; Jones, S.; Fields, L. (Los Alamos National Lab., NM (USA); USDOE Oak Ridge Operations Office, TN; Goodyear Atomic Corp., Piketon, OH (USA); Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 1983. Contract W-7405-ENG-36. 14p. (CONF-831106—6). NTIS, PC A02/MF A01. Order Number DE84003182.

From Topical meeting on safeguards technology - the process safeguards interface; Hilton Head Island, SC, USA (28 Nov 1983).

Portions are illegible in microfiche products.

Holdup of nuclear material in process equipment is one of the major sources of uncertainty in materials balances, particularly for high-throughput facilities with large equipment and extensive piping, such as gaseous diffusion uranium-enrichment plants. Locating and measuring the holdup while the plant is operating is a challenging problem because of background from the process material and the neighboring equipment. This paper reports NDA measurements performed at the Goodyear Atomic Gaseous Diffusion Plant, Portsmouth, Ohio, on enrichment equipment at the higher enrichment and ($>10\%$ ^{235}U isotopic abundance) of the cascade. Both neutron and gamma-ray measurements were made to locate anomalously large deposits in converters and compressors and, within the limitations of the techniques, to quantify the amount of the deposit.

4488 **(LA-UR—83-3386) Determination of plutonium isotopic ratios by using low-energy gamma-ray spectroscopy.** Li, T.K. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 8p. (CONF-831106—4). NTIS, PC A02/MF A01. Order Number DE84003834.

From Topical meeting on safeguards technology - the process safeguards interface; Hilton Head Island, SC, USA (28 Nov 1983).

A nondestructive gamma-ray technique has been developed to determine plutonium isotopic ratios. The technique is based on the high-intensity, low-energy gamma rays at 43.48, 45.23, 51.63, 59.54, and 64.83 keV for ^{238}Pu, ^{240}Pu, ^{239}Pu, ^{241}Am, and ^{241}Pu, respectively. The results demonstrate that this technique can accurately measure plutonium samples in a timely manner and in a wide range of masses, isotopic contents, chemical forms, and ages from chemical processing.

4489 **(SAND—83-2392C) Computer safeguards system for the IAEA inspectors at GCEP.** Baker, A.L.; Harris, P.W.; Fienning, W.C. (Sandia National Labs., Albuquerque, NM (USA); Los Alamos National Lab., NM (USA)). 1983. Contract AC04-76DP00789. 6p. (LA-UR—83-3356; CONF-831106—3). NTIS, PC A02/MF A01. Order Number DE84003211.

From Topical meeting on safeguards technology - the process safeguards interface; Hilton Head Island, SC, USA (28 Nov 1983).

The Safeguards Data System (SDS), which is being developed to provide improved safeguards for the Gas Centrifuge Enrichment Plant at Portsmouth, Ohio, is described. The SDS is an automated, integrated computer data acquisition and data management system. It is designed to operate in a continuous unattended mode to provide attributes measurements, summary materials accounting data, and on-site data analysis capability to the IAEA inspectors at the GCEP facility.

4490 **Spent fuel photon and neutron source spectra.** Hermann, O.W.; Alexander, C.W. (Oak Ridge National Laboratory, Oak Ridge, TN 37830). *Transactions of the American Nuclear Society;* **44**: 474-475(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

4491 **Optimization of NDA measurements in field conditions for safeguards purposes.** Beets, C. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Carolis, M. de; Keddar, A. (International Atomic Energy Agency, Vienna (Austria)); Menlove, H.O. (Los Alamos National Lab., NM (USA)). pp 121-136 of Nuclear safeguards technology 1982. Proceedings of an international symposium on recent advances in nuclear material safeguards organized by the IAEA and held in Vienna, 8-12 November 1982. Vol. 2. Vienna, Austria; IAEA (1983). (CONF-821119—; IAEA-SM—260/108).

From International symposium on recent advances in nuclear materials safeguards; Vienna, Austria (8 Nov 1982).

In the application of NDA techniques for safeguards verification it is important to realize that the transition from laboratory development to routine use requires fully documented field tests in order to define practicable NDA standards accepted both by the operator and by the Agency. The objective of IAEA Research Contract No. 2274 RB, initiated in 1980, concerns the optimization of NDA measurements in field conditions for safeguards purposes. It foresees the following programme of measurements: (a) Determination of ^{240}Pu equivalent of Pu in bulk by passive neutron coincidence using the high level neutron coincidence counter (HLNCC); (b) Determination of Pu isotopic ratios of Pu in bulk by transmission gamma spectrometry using intrinsic germanium detector and portable silena MCA; (c) Verification of ^{235}U and ^{238}U contents in PWR fuel assemblies by fission neutron counting in active and passive modes using the neutron collar technique; (d) Pu total verification by calorimetry and gamma spectrometry for small samples (1st type calorimeter), for bulk samples up to 2 kg PuO_2 (2nd type calorimeter) and fast reactor rods (3rd type calorimeter).

4492 **DHATOZ: a computer code for the statistical analysis of operator-inspector measurement differences.** Bush, W.J. (International Atomic Energy Agency, Vienna (Austria)); Bracey, J.T. (New Brunswick Lab., Argonne, IL (USA)). pp 263-274 of Nuclear safeguards technology 1982. Proceedings of an international symposium on recent advances in nuclear material safeguards organized by the IAEA and held in Vienna, 8-12 November 1982. Vol. 2. Vienna, Austria; IAEA (1983). (CONF-821119—; IAEA-SM—260/143).

From International symposium on recent advances in nuclear materials safeguards; Vienna, Austria (8 Nov 1982).

DHATOZ is a computer program designed to aid the safeguards data analyst to objectively assess operator-inspector measurement differences occurring among a sample of items or materials selected randomly by the inspector from the operator's physical inventory listing. DHATOZ provides the requisite calculations for estimating process, systematic, and random error variances. These variance estimates are then used to test hypotheses concerning the operator's stated material balance. DHATOZ includes features to detect outliers and plots to graphically reveal the underlying structure of the paired measurement data. A recent development by Jaech is incorporated to avoid the problem of negative variance estimates.

4493 **Use of (D, MUF) and maximum likelihood methods for detecting falsification and diversion in data verification problems.** Goldman, A.S. (Los Alamos National Lab., NM (USA)); Beedgen, R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). pp 275-285 of Nuclear safeguards technology 1982. Proceedings of an international symposium on recent advances in nuclear material safeguards organized by the IAEA and held in Vienna, 8-12 November 1982. Vol. 2. Vienna, Austria; IAEA (1983). (CONF-821119—; IAEA-SM—260/102).

From International symposium on recent advances in nuclear materials safeguards; Vienna, Austria (8 Nov 1982).

The investigation of data falsification and/or diversion is of major concern in nuclear materials accounting procedures used in international safeguards. In this paper, two procedures, denoted by (D, MUF) and LR (Likelihood Ratio), are discussed and compared when testing the hypothesis that neither diversion nor falsification has taken place versus the one-sided alternative that at least one of these parameters is positive. Critical regions and detection probabilities are given for both tests. It is shown that the LR method outperforms (D, MUF) when diversion and falsification take place.

4494 **Loss pattern identification in near-real-time accounting systems.** Argentesi, F. (Commission of the European Communities, Ispra (Italy). Joint Research Centre); Hafer, J.F.; Markin, J.T.; Shipley, J.P. (Los Alamos National Lab., NM (USA)). pp 373-382 of Nuclear safeguards technology 1982. Proceedings of an international symposium on recent advances in nuclear material safeguards organized by the IAEA and held in Vienna, 8-12 November 1982. Vol. 2. Vienna, Austria; IAEA (1983). (CONF-821119—; IAEA-SM—260/52).

From International symposium on recent advances in nuclear materials safeguards; Vienna, Austria (8 Nov 1982).

To maximize the benefits from an advanced safeguards technique such as near-real-time accounting, sophisticated methods of analysing sequential material accounting data are necessary. The methods must be capable of controlling the overall false-alarm rate while assuring good power of detection against all possible diversion scenarios. A method drawn from the field of pattern recognition and related to the alarm-sequence chart appears to be promising. Power curves based on Monte Carlo calculations illustrate the improvements over more conventional methods.

4495 **Statistical methods for nuclear materials safeguards: an overview.** Goldman, A.S.; Picard, R.R.; Shipley, J.P. (Los Alamos National Lab., NM). *Technometrics;* **24**: No. 4, 267-294(Nov 1982). (CONF-820878—).

From Institute of mathematics and statistics annual meeting; Cincinnati, OH, USA (16 Aug 1982).

The origins and development of safeguards work for nuclear materials are briefly reviewed: A variety of problems commonly encountered and the role of statistics in addressing them are discussed.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0702 Radiation Sources

REFER ALSO TO CITATION(S) 4459, 5241, 5244, 5245

4496 (UCRL—89825) Food processing with electrically generated photon irradiation. Matthews, S.M. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 19p. (CONF-8311102—1). NTIS, PC A02/MF A01. Order Number DE84002454.

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

A conceptual design for a portable electric food irradiation processing machine is presented and analyzed for cost assuming the required accelerators are available for $1.5 million each. It is shown that food can be processed to 1 kGy for a price of $5.98/ton.

4497 Rotating-crystal pulse shaper for use on a pulsed neutron source. Carpenter, J.M. (Argonne National Lab., IL (USA)); Carlile, C.J. (Science and Engineering Research Council, Chilton (UK). Rutherford Appleton Lab.). *Journal of Applied Crystallography;* **16**: No. 4, 363-369(1 Aug 1983).

A pulse-shortening device is described for use on pulsed thermal-neutron sources. The device employs rotating single crystals and has applications in the design of high-resolution cold-neutron spectrometers.

0703 Isotopic Power Supplies

4498 (LA—9894-PR) Space Nuclear Safety Program, March 1983. Progress report. Bronisz, S.E. (comp.). (Los Alamos National Lab., NM (USA)). Sep 1983. Contract W-7405-ENG-36. 11p. NTIS, PC A02/MF A01. Order Number DE84002259.

This technical monthly report covers studies related to the use of $^{238}PuO_2$ in radioisotope power systems. They pertain to the General-Purpose Heat Source and to helium release.

4499 (LA—9906-PR) Space nuclear safety program, April 1983. Progress report. Bronisz, S.E. (comp.). (Los Alamos National Lab., NM (USA)). Oct 1983. Contract W-7405-ENG-36. 17p. NTIS, PC A02/MF A01. Order Number DE84002325.

This program related to the use of plutonium-238 dioxide in radioisotope power systems. Reported in this document is a phosphorus effects experiment and a compatibility test for the General-Purpose Heat Source. (DLC)

4500 (LA—9918-PR) Space nuclear safety program, May 1983. Progress report. Bronisz, S.E. (comp.). (Los Alamos National Lab., NM (USA)). Oct 1983. Contract W-7405-ENG-36. 11p. NTIS, PC A02/MF A01. Order Number DE84002324.

The studies related to the use of $^{238}PuO_2$ in radioisotope power systems, pertained to the General-Purpose Heat Source (compatibility and safety verification) and to the Light-Weight Radioisotope Heater units (overpressure and impact tests).

4501 (LA—9934-PR) Space nuclear safety program, June 1983. Progress report. Bronisz, S.E. (comp.). (Los Alamos National Lab., NM (USA)). Nov 1983. Contract W-7405-ENG-36. 18p. NTIS, PC A02/MF A01. Order Number DE84003555.

This technical monthly report covers studies related to the use of $^{238}PuO_2$ in radioisotope power systems. Most of the studies discussed here are ongoing. Results and conclusions described may change as the work continues.

08 HYDROGEN

4502 Recap of the World Hydrogen Energy Conference IV. Kelley, J.H. (Jet Propulsion Laboratory, Pasadena, CA). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **3**: 1184(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

The World Hydrogen Energy Conference IV featured presentations of more than 200 technical hydrogen papers from 25 countries as well as Exhibits of hydrogen equipment and technology. Hosted by the California Institute of Technology and sponsored by the Atlantic Richfield Foundation, the Conference was held in Pasadena, June 13-17, 1982. As Chairman of the Organizing Committee, the author will provide overviews of the Conference; this will include the flavor of the results, the new, the significant, the major points of agreement and the major points of disagreement. Interesting observations from behind-the-scenes will be included as appropriate.

0801 Production

REFER ALSO TO CITATION(S) 4855, 5579

4503 A viable process for producing hydrogen synfuel using nuclear fusion heat. Galloway, T.R.; Brown, L.C. (Mittelhauser Corporation, Berkeley, CA 94705). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **3**: 1150-1159(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

This paper describes the results of a two-year program to develop a viable process for the production of hydrogen synfuel from water using the General Atomic Sulfur-Iodine thermochemical cycle, driven by thermal and electrical energy supplied by a Tandem Mirror Fusion Reactor. This is the first process to be evolved that has both an attractive thermal efficiency of around 50% and attractive H2 fuel costs of around $10/GJ. The authors show that the key to their TMR/Synfuels plant concept is the development of an interface between the TMR and the cycle that uses as much of the thermal energy as possible and in the most cost-effective manner. At every step in the chemical engineering design development the authors were sensitive to cost issues and thermodynamic availability, simultaneously. There was no single innovation that allowed them to complete the design successfully, but a whole series of small contributions all taken together.

4504 Current research in advanced water electrolysis in the United States and abroad. Bonner, M.; Botts, T.; McBreen, J.; Mezzina, A.; Salzano, F.; Yang, C. (Brookhaven National Laboratory, Upton, NY). *Proceedings, Intersociety Energy Conversion Engineering Conference;* **3**: 1197-1201(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

An overview on advanced water electrolysis systems for H_2 production is provided. The survey of the work sponsored by the Department of Energy through Brookhaven National Laboratory (BNL) includes: General Electric's scale-up of SPE technology; Teledyne's identification of the best available electrodes and separators for advanced alkaline systems; Life Systems' testing of a novel static water feed concept; and advanced electrolysis research at BNL. Also included is recent progress in Canada, Europe (development of inorganic ion exchange membranes), and Japan (alkaline and SPE plants) which is based on information reported to the International Energy Agency.

0806 Industrial And Commercial Use

REFER ALSO TO CITATION(S) 5157

0808 Properties

4505 **Compatibility of steel pipelines with hydrogen.** Holdbrook, J.H.; Cialone, H.J.; Groeneveld, T.P.; Mayfield, M.E. (Battelle, Columbus Laboratories, Ohio). *Proceedings, Intersociety Energy Conversion Engineering Conference;* 3: 1142-1146(Aug 1982). (CONF-820814—).

From 17. Intersociety Energy Conversion Engineering conference; Los Angeles, CA, USA (8 Aug 1982).

The future of hydrogen gas as a practical energy source depends not only on whether it can be produced efficiently and economically but also on whether it can be distributed conveniently and safely to consumers. The existing underground natural gas pipeline system could represent one means for that distribution if no problems are encountered using those pipelines to transport hydrogen gas. Of particular importance is the potential for hydrogen-environment embrittlement of line-pipe steel. There is a basic incompatibility between hydrogen gas and line-pipe steel due to a phenomenon called hydrogen-environment embrittlement. A review of the phenomenon of hydrogen-environment embrittlement of ferritic steels is given with the purpose of identifying the guidelines that need to be followed to ensure safe transport of hydrogen in pipelines.

09 OTHER SYNTHETIC AND NATURAL FUELS

0901 Hydrocarbon Fuels

REFER ALSO TO CITATION(S) 4282, 4527, 4529, 4912, 5393

4506 **(DOE/ER/12058—2) Promoter modifications of catalytic activity and selectivity. Progress report, April 1, 1982-November 30, 1983.** Falconer, J.L. (Colorado Univ., Boulder (USA). Dept. of Chemical Engineering). 30 Nov 1983. Contract AC02-82ER12058. 38p. NTIS, PC A03/MF A01. Order Number DE84003179.

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Carbon monoxide hydrogenation to methane and higher hydrocarbons was changed significantly by the addition of alkali promoters to supported nickel catalysts. Alkali promoters in general were observed to decrease activity and increase olefin selectivity. However, the oxide support significantly affects the modifications induced by the promoters. On SiO_2, Al_2O_3 and TiO_2, overall activity decreased; on $SiO_2.Al_2O_3$, activity increased with promoters and a maximum was observed at low potassium concentrations. Differential reactor studies were also used to show that the support and promoter concentrations had a larger influence on activity and selectivity than catalyst preparation (pre-, co- or postimpregnation) and promoter salt used (KCl, K_2CO_3, $K_2C_2O_4$, KOH). Temperature-programmed reaction (TPR) also showed that alkali decreased the rates of both carbon monoxide and carbon hydrogen; the decreased rates were not due to site blocking. Excellent agreement was obtained between TPR and steady-state kinetics. Temperature-programmed desorption indicated that the decreased hydrogenation rates of CO, carbon and of olefin were due to weakened hydrogen bonding. The CO desorption was also significantly changed by promotion.

4507 **(DOE/R6/10947—T1) Development of a multi-resource alternate energy facility. Final technical report.** Keel, J.S. (Keel (James S.), Harrison, AR (USA)). 1 Apr 1981. Contract FG46-79R610947. 26p. NTIS, PC A03/MF A01. Order Number DE84003236.

A grant was awarded for development of a bio-gas alternate energy project on a 60 acre cattle farm on the outskirts of Harrison, Arkansas. The project required construction of a bio-gas plant to demonstrate that methane gas produced from livestock manure can lead to semi-independence of rural areas from traditional energy resources, and that the effluent fertilizer produced will reduce reliance on chemical fertilizers. A supplemental grant was awarded for adding a solar hot water heater for the bio-gas plant, and a wind powered electrical generating system for the project. Thus, this is a multi-resource alternate energy facility that uses solar, wind and bio-conversion to produce energy for the farm. The facility has three sub-systems: (a) A bio-gas plant which produces methane gas which can be used for hot water heat or other human comfort needs, generation of electricity, a rich effluent alternate fertilizer, and an alternate vehicle fuel. (b) A solar hot water heater that provides supplemental heat for the methane-powered bio-gas digester circulating hot water system. (c) A wind powered electrical generating system which supplements farm and residential electrical demands. The goals of the facility are to: (a) Introduce small-scale alternate energy technology into farming operations. (b) Demonstrate that small-scale energy alternatives are practical and attainable. (c) Stimulate production of alternate energy technology in Agriculture.

4508 **(DOE/R6/10981—T1) Methane generation from animal wastes.** Fulton, E.L. (Tarleton State Univ., Stephenville, TX (USA). Dept. of Agriculture). Jun 1980. Contract FG46-79R610981. 32p. NTIS, PC A03/MF A01. Order Number DE84003503.

The conversion of manure to biogas via anaerobic digestion is described. The effluent resulting from the conversion retains fertilizer value and is environmentally acceptable. Discussion is presented under the headings: methane formation in the digester; the Tarleton State Poultry Waste to Methane production system; operating experience at Tarleton State; economics of biogas production from poultry waste; construction cost and biogas value; energy uses; feed and waste processing; and advantages of anaerobic digestion. (DMC)

4509 **(DOE/R6/12019—T1) Valle Grande solar methane algae project. Final report.** Calentine, D.D. (Calentine (Della D.), Las Vegas, NM (USA)). 29 Oct 1982. Contract FG46-80R612019. 13p. NTIS, PC A02/MF A01. Order Number DE84003228.

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Manure is added to a pond enclosed in a hexadome greenhouse for utilization of solar energy. While several manures were tested, a combination of rabbit and chicken manures generated the most methane, 10 to 12 CF per day. Pig manure alone appeared to have a low yield. Additional ponds were filled with fresh water and algae cultures were grown and harvested. An attempt was made to process household grey water in these algae ponds. (DMC)

4510 **(DOE/R6/12083—T1) Methane (biogas) generator using aquatic plants as feedstock. Final report, November 1982 to February 1983.** Whiteside, C.H. (Ana-Lab Corp., Kilgore, TX (USA)). 8 Mar 1983. Contract FG46-81R612083. 19p. NTIS, PC A02/MF A01. Order Number DE84003535.

Highlights of progress are summarized in this final report. Primary areas of interest were: determination of maximum growth rates of water hyacinths on a continuing basis; determination of materials and design which are most appropriate for the conveyor; development of an automatic conveyor system; determine nitrogen needs to maintain optimum growth of hyacinths. Construction has been completed except for modification although no methane has been collected at this time. (DMC)

4511 **(DOE/R6/12085—T1) Single stage anaerobic digester at Tarleton State University. Final report.** (Tarleton State Univ., Stephenville, TX (USA)). 1980. Contract FG46-81R612085. 14p. NTIS, PC A02/MF A01. Order Number DE83017946.

The design and operation of the demonstration plant facilities at Tarleton State University to produce methane in a single stage anaerobic digester are described. A combination of manures from hogs and poultry are used as feedstock. Uses for the methane, cost of the digester, and value of the energy produced are discussed. During the 21 months of operation, 310 people have visited the project. (DMC)

4512 (TENRAC/EDF—108) On-site energy production from agricultural residues. LePori, W.A.; Parnell, C.B. Jr.; Lacewell, R.D.; Pollock, T.C.; Griffin, R.B. (Texas A and M Univ., College Station (USA)). 31 Aug 1983. 143p. NTIS, PC A07/MF A01. Order Number DE84900407.

Objectives of the current research project were: (1) evaluate biomass fluidized-bed gasifier-steam boiler energy conversion capabilities; (2) measure material erosion-corrosion properties of gas at various locations within the biomass energy conversion unit; (3) continue performance measurements and evaluation of gas cleanup systems; (4) continue economic analysis of biomass power producing system; and (5) consult with groups selected by TENRAC for site-specific energy system design. Results of this research show that biomass fueled energy producing systems are both technically and economically feasible. Using biomass fuel in a fluidized bed, combustible gas can be produced which has a heating value near 6.2 MJ per cubic meter. This LCV gas has been burned in a fire tube boiler to generate steam. More than 50% of the input fuel energy was converted to steam, which was flared. 31 references, 48 figures, 24 tables.

4513 (TENRAC/EDF—110-Vol.1) Engineering evaluation of plant oils as diesel fuel. Final report. Vol. I. Engler, C.R.; Johnson, L.A.; Lepori, W.A.; Yarbrough, C.M. (Texas Agricultural Experiment Station, College Station (USA)). 13 Sep 1983. 90p. NTIS, PC A05/MF A01. Order Number DE84900429.

This project includes evaluations of cottonseed oils and sunflower oil ethyl esters in both direct injection and precombustion chamber design diesel engines. It is one part of a major research program at Texas A and M University to study the technical feasibility of using plant oils or animal fats as alternative diesel fuels. Goals for the overall program are to define physical and chemical characteristics and optimum processing methods required for high quality alternative diesel fuels from plant or animal oils and to investigate effects of engine design on alternative fuel performance. This report describes work done under the current contract which includes evaluations of cottonseed oils and sunflower oil interesterified with ethanol as alternative diesel fuels. 15 figures, 18 tables.

4514 (TVA/PUB—84/5) Energy from biomass state-of-the-art and future goals. Pile, R.S.; Badger, P.C. (National Fertilizer Development Center, Muscle Shoals, AL (USA)). Apr 1983. 26p. (CONF-830226—3). NTIS, PC A03/MF A01. Order Number DE84900354.

From 10. WATTEC annual energy conference; Knoxville, TN, USA (25 Feb 1983).

This report is limited primarily to discussions related to biomass energy for agricultural production, energy needs for agriculture, and traditional energy sources normally used to meet these needs. Possible biomass energy substitutions and/or uses, available technologies, constraints to implementation, and future needs for onfarm implementation are also considered. Discussion is presented under the headings: energy needs for production; direct combustion/gasification; biogas; alcohol fuels; vegetable oil fuels; constraints; and the future.

0902 Alcohol Fuels

REFER ALSO TO CITATION(S) 4384, 4394, 4514, 4524, 4892

4515 (DOE/AF/92505—T1) Alcohol fuels technology program: Byng public school. Final progress report. (Byng Public School, Ada, OK (USA)). 1 Apr 1982. Contract FG46-81AF92505. 5p. NTIS, PC A02/MF A01. Order Number DE84003500.

This is the final report for the Energy Grant awarded to Byng School for the purpose of building a distillery and producing fuel alcohol to be used in the school vehicles. The distillery has been built and alcohol has been produced and tested. At the time of the grant award, it was feared gasoline would soon retail for $4 per gallon. Fortunately, this has not been the case and the school is able to purchase gasoline for about 97 cents. As it cost 93 cents per gallon to produce alcohol in the distillery, the plan to produce alcohol for use in the busses has temporarily been set aside. We are holding the distillery ready for production as insurance against an increase in gasoline price. The plant and process are described.

4516 (DOE/AF/92506—T1) Low energy alcohol distillation. Mitchell, R.S. (Mitchell (Richard S.), Jonesboro, AR (USA)). Dec 1981. Contract FG46-81AF92506. 7p. NTIS, PC A02/MF A01. Order Number DE84003511.

This final report describes the results of a project to design a molecular still utilizing solar energy and vacuum for under $1,000.00. The still was constructed and operated, however, the goal of producing 6 to 30 gal per day of 80 to 100% ethanol was not reached. The best output was only 1/2 gal per day. Problems involving leaks in the distillation column were responsible for the poor output. The solar pot was replaced and the leaking column bypassed in order to remedy the problem. General methods were employed in an attempt to reach and maintain higher temperatures within the tank. Problem areas and their proposed remedial actions are discussed. (DMC)

4517 (DOE/AF/92507—T1) Evaluation of an ethanol distillation/dehydration process utilizing ammonium nitrate as an extractive agent. Final progress report. Boone, J.E.; Boone, N.H. (Boone Enterprises, Inc., Baton Rouge, LA (USA)). 10 Jan 1981. Contract FG46-81AF92507. 66p. NTIS, PC A04/MF A01. Order Number DE84003499.

The purpose of this grant was to evaluate a process where a fertilizer is used as an extractive agent for the distillation/dehydration of ethanol. Preliminary studies indicated such a process would have certain advantages over the traditional benzene process for producing gasohol quality ethanol. This work had two main objectives. First, commercial fertilizers were screened to identify those which would break the ethanol-water azeotrope. Then, process economics for this process were compared with the benzene process. During this study, seven fertilizers were screened. Only ammonium nitrate had sufficient effect to break the azeotrope. Once a suitable fertilizer was identified, enough additional data was obtained to make process design calculations. The process evaluation which followed showed that at a 20MM production rate distillation costs ranged from 31 cents/gal to 38 cents/gal (depending on the reflux ratio). This compares well with the 36 cent/gal cost that was calculated for the benzene process. The principle difference between the above numbers is the energy consumption. A price/volume relationship was also established for this process. The principle disadvantage of this process is the high consumption of fertilizer. It was hoped that the fertilizer usage could be limited to that needed to grow the crops. Actual usage is estimated to be 6 to 10 times this requirement. Thus, if this process is used, a market for this fertilizer must be available. This study is based on lab scale experimental results. While these results are adequate for this economic evaluation, the process should be through a pilot plant evaluation before definitive process design work is undertaken. 16 references, 10 figures, 25 tables.

4518 (DOE/CE/50305—3) Review of problems in the small-scale farm production of ethanol. White, H.M. (Aerospace Corp., El Segundo, CA (USA). Mobile Systems Directorate). Jul 1983. Contract AC01-82CE50305. 31p. NTIS, PC A03/MF A01. Order Number DE84003906.

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This report reviews the current status of small, farmer-operated ethanol production facilities. The characteristics and operating problems associated with present plants are reviewed with respect to technical, economic, and institutional issues. Information was obtained from recent publications and numerous telephone calls to state and federal officials and the producers themselves. It is concluded that, in most parts of the country, small-scale alcohol production has been reduced to relatively few farm plants, due primarily to several unfavorable economic factors. While both large and small facilities have been squeezed by rising feedstock costs and lower alcohol selling prices, the farmer-producer is burdened by additional constraints because of the small scale of his operations. It is not usually profitable for him to recover all the valuable by-products from the feedstock, such as gluten, corn oil, and carbon dioxide from corn conversion. He may not be able to use or market the wet alcohol and stillage he produces. Other difficulties often in-

clude high fuel costs, lack of financial and technical assistance, and excessive labor requirements.

4519 **(DOE/R4/10158—T1) MOONSHINER I: personal fuel production. Final report.** Holloman, R.L. (Holloman (Randy L.) and Associates, Valdosta, GA (USA)). 1981. Contract FG44-80R410158. 70p. NTIS, PC A04. Order Number DE84000778.

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This report describes the research and design of a self-controlling cellulose to liquid fuel conversion reactor. Initial research suggested the possibility of utilization of a bacterium named Clostridium thermocellum as a conversion agent due to its unique metabolism. Further research showed that work at other locations supported that possibility. Work was begun on the apparatus and techniques necessary for completion. Bad technique, design or supplies resulted in many months of ineffectual work while progress was being made on similar research elsewhere. Other projects' data was used to continue the information collection and design stages of this effort.

4520 **(DOE/R6/12032—T1) Use of dry extrusion coolers for gelatinizing grain starch. Final report.** Downs, W.; Clary, B.L. (Oklahoma State Univ., Stillwater (USA). Dept. of Agricultural Engineering). 10 Jun 1983. Contract FG46-81R612032. 66p. NTIS, PC A04/MF A01. Order Number DE84003128.

The use of dry extrusion cookers for gelatinizing grain starch has been investigated. It is possible to consistently achieve better conversion with extrusion than with standard batch methods. Best performance was achieved at high temperatures and low moisture content. The effect of temperature gradient along the barrel was also important and appeared to be related to the nature of starch being processed. The effect of substrate concentration, dextrose equivalence, and agitation on the conversion of starch to sugar by a commercially available glucoamylase has been investigated. The effect of alcohol and a typical fungicide is also reported. Rate was independent of the fungicide but considerably affected by starch concentration, dextrose equivalent, and alcohol percentage. Velocity was unaffected by agitation or background glucose level. Enzyme kinetics are defined and discussed. The traditional Michaelis-Menten equation describing enzyme conversion as a function of substrate concentration appears to be a satisfactory for substrate concentrations of 5% solids or less. An equation describing velocity over a substrate range from 0 to 27.5% by weight was determined and presented.

4521 **(DOE/R6/12043—T1) Engineering evaluation of small-scale ethanol plant designs.** Radovich, J.M.; Penrod, S.L. (Oklahoma Univ., Norman (USA). School of Chemical Engineering and Materials Science). Oct 1981. Contract FG46-80R612043. 81p. NTIS, PC A05/MF A01. Order Number DE84002999.

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The goals of this project were to provide engineering process design information for farm-scale ethanol-fermentation plants having ethanol capacities of 10 gph (gal/hr) 30 gph and 50 gph. We were specifically interested in providing design information for the various plant components/equipment which could be used by the farmer to either construct himself or to request a bid from an equipment supplier. Sizes of the major pieces of equipment to accomplish each processing step were thus specified rather than mechanical specifications, because several mechanical designs are usually available to satisfy the processing need. Each mechanical design is a trade-off of cost, efficiency, flexibility, and capacity, with no one design being the optimum with respect to each criteria. The design information provided in this report provides the farmer with the process requirements which serve as a basis for evaluating the various equipment options available. The report is divided into six sections. The first four are directly related to the processing steps involved in fermentation of grain to ethanol: fermentation, distillation, dehydration, utilities and byproducts. Corn was the fermentable grain which was the basis for all our process calculations. The fifth section deals briefly with the costs of farm-scale plants, while the last section summarizes the information obtained in our evaluation of commercially available plants with capacities of 10 to 50 gph ethanol product. 15 references, 13 figures, 20 tables.

4522 **(TENRAC/EDF—109) Ethanol production in small- to medium-size facilities for use in internal combustion engines. Final report.** (Texas Energy and Natural Resources Advisory Council, Austin (USA)). Aug 1983. 182p. NTIS, PC A09/MF A01. Order Number DE84900430.

The general areas in which research has been directed are ethanol production from alternate feedstocks, stillage utilization and processing, and ethanol usage in internal combustion engines. This report covers research conducted between September 1, 1981 and August 31, 1983. Extensive research on ethanol yield from sweet potatoes has shown that alcohol production can be as high as 137 liters per tonne. Some dilution water was required to handle the sweet potato mash as a slurry. This resulted in low ethanol concentrations in the beer (6%). Fermentation of carrot culls yielded 26 to 36 liters of ethanol per tonne of carrots. As with sweet potatoes, dilution water resulted in low ethanol concentrations in the beer. Seed grain sorghum that had been chemically treated with the fungicide Captan and the pesticides heptachlor and methoxychlor was feremented and distilled. The chemical seed treatments had no significant effect on ethanol yield from grain sorghum. Captan was destroyed in the cooking process. Methoxychlor and heptachlor residue remained throughout the process and most was recovered in the wet pressed stillage solids. Research with stillage processing and treatment had the overall goal of developing processes for recovering animal and plant nutrients for reuse and reducing water pollution potential. An ethanol vaporizing system has been installed on a natural gas spark ignition engine. The system can be retrofitted to spark ignition engines without changes to the original fuel system. Vaporized 170 to 180 proof ethanol proved to be a satisfactory fuel. 56 references, 21 figures, 40 tables.

0903 Inorganic Hydrogen Compound Fuels

REFER ALSO TO CITATION(S) 5157

13 HYDRO ENERGY

1305 Economics And Management

4523 **(CONF-8211127—) Proceedings of the hydro power financing and power marketing seminar.** (Idaho Dept. of Water Resources, Boise (USA)). 1982. Contract FG01-79RG10189. 79p. NTIS, PC A05/MF A01. Order Number DE84000057.

From Hydro power financing and power marketing seminar; Boise, ID, USA (15 Nov 1982).

Six informal presentations (and a luncheon address) are included: economic analysis of hydropower projects, PURPA and hydropower developers, project financing, project financing for public entities, project financing for private developers, and bank financing. (DLC)

14 SOLAR ENERGY

1405 Solar Energy Conversion

REFER ALSO TO CITATION(S) 4508, 4509, 4510, 4511, 4512, 4513, 4514, 4515, 4516, 4517, 4518, 4519, 4520, 4521, 4522, 5393

4524 **(DOE/AF/92504—T1) Production of fuel alcohol from Jerusalem artichoke tops.** (VIA, Inc., Albuquerque, NM (USA)). 1983. Contract FG46-81AF92504. 10p. NTIS, PC A02/MF A01. Order Number DE84003510.

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The objective of this research program is to demonstrate fuel alcohol production in New Mexico using the Jerusalem artichoke and local resources. This final report summarizes progress made during the course of the project. The planting and cultivation of the tubers are described as well as the construction of the eth-

anol plant. During the grinding of the tubers, the Bowie gear pump failed and a larger Mayo pump was purchased. Results indicate that Jerusalem artichokes will grow well in this area of New Mexico; water requirements are about the same as for corn and cultivation is only necessary until plant height is 18 inches. (DMC)

4525 **(DOE/CH/00178—T18) Development of copper sulfide/cadmium sulfide thin-film solar cells. Fourteenth technical progress report, October 1, 1982-December 31, 1982.** Szedon, J.R.; Krishnaswamy, S.V.; McMullin, P.G. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 1 Sep 1983. Contract AC02-77CH00178. 25p. NTIS, PC A02/MF A01. Order Number DE84002239.

We have shown that all of the laser-treated, thin-film Cu_xS/CdS solar cells made at Westinghouse show less degradation on aging in a wet oxygen ambient than do untreated, control cells. Differences in the effects of laser treatment are attributed to variations in optical absorption which are related to the details of cell processing.

4526 **(DOE/ER/10911—5) Investigation of the structure of photosynthetic reaction centers. Progress report, January 6, 1983-November 5, 1983.** van Willigen, H. (Boston Univ., MA (USA)). Nov 1983. Contract AC02-81ER10911. 11p. NTIS, PC A02/MF A01. Order Number DE84002886.

Dimer formation of tetra(4-sulfonatophenyl)porphyrin and its Zn and Pd complexes has been studied using optical and triplet ESR spectroscopy. The data give information on dimer geometry as well as on dimerization effects on photo-excited triplet properties. It is found that dimerization effects mimic those associated with a transition from in vitro bacteriochlorophyll monomers to primary donor bacteriochlorophyll in reaction centers of photosynthetic bacteria. ENDOR study was made of the solvation of a porphyrin cation radical. The study established that the ENDOR technique can provide information on weak interactions between paramagnetic macrocycles and surrounding solvent molecults. ENDOR instumentation has been adapted to accomodate a new Oxford Instruments helium cryostat.

4527 **(DOE/R6/12009—T1) Energy demand for harvesting aquatic biomass in the natural environment. Final report.** Broussard, N.D.; Broussard, P.A. (Hyacinthetics Corp., Lake Charles, LA (USA)). Feb 1982. Contract FG46-80R612009. 30p. NTIS, PC A03/MF A01. Order Number DE84003536.

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The goal of this project is to utilize water hyacinths for the production of energy. The results of the research indicated that although the net energy balance from a system involving harvesting, transporting, and anaerobically digesting wild water hyacinths is severely impacted by the collection of the biomass in the wild state, the impact is not nearly as severe as that resultant from the requirements for digestion heat input. Research into the utility of biota as pestilent as the water hyacinth can only advance man's intergration into environmental harmony. This is especially true in the abundant waterways of Louisiana, where this experiment was carried out, which are typical of the semi-tropical coast-lands adjacent to the Gulf of Mexico.

4528 **(N—8326174) Spatially characterizing effective timber supply.** Berry, J.K.; Sailor, J. (Yale Univ., New Haven, CT (USA)). 1982. 11p. NTIS, PC A14/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 1 p 256-266 (SEE N83-26155 15-43).

The structure of a computer-oriented cartographic model for assessing roundwood supply for generation of base load electricity is discussed. The model provides an analytical procedure for coupling spatial information of harvesting economics and owner willingness to sell stumpages. Supply is characterized in terms of standing timber of accessibility considering various harvesting and hauling factors and of availability as affected by ownership and residential patterns. Factors governing accessibility to timber include effective harvesting distance to haulic roads as modified by barriers and slopes. Haul distance is expressed in units that take into account the relative ease of travel along various road types to a central processing facility. Areas of accessible timber are grouped into spatial units, termed 'timbersheds', of common access to particular haul road segments that belong to unique 'transport zones'. Timber availability considerations include size of ownership parcels, housing density and excluded areas. The analysis techniques are demonstrated for a cartographic data base in western Massachusetts.

4529 **(NZERDC—93) Economic and energetic evaluation of whole crop harvesting on cropping farms in Canterbury. Final report.** Clark, J.S. (New Zealand Energy Research and Development Committee, Auckland). May 1983. 51p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE84900369.

This study examines the operational and design factors which influence overall combine performance, and considers a whole crop system as a possible alternative method of crop harvesting. Research and commercial applications of the whole crop concept are discussed. In order to determine the feasibility of such a system in New Zealand, stochastic computer simulation models of the combining and the whole crop systems have been constructed. Two versions of the whole crop system are considered, the first using several PTO forage harvesters, the second using a single self-propelled forage harvester. The sensitivity of each system to changes in speed of harvesting and grain:non-grain ratio is determined over periods of identical weather conditions based on historical data. Agronomic, economic and energetic characteristics of each system are evaluated and the whole crop system appears to offer advantages over the traditional combining system. Substantial savings (up to 62 percent) were possible in capital investment on machinery. Potential for energy conservation is noted, with decreases in diesel fuel consumption of up to 46 percent. Not only is the direct energy requirement lower, but indirect energy involvement (in the form of plant and machinery) is substantially reduced. It is concluded that the whole crop concept presents a worthwhile alternative to combine harvesting on arable cropping farms, and that it could have a major part to play in the future of New Zealand's arable cropping industry. There also appears great potential for the system to be an energy producer via anerobic digestion of surplus straw to produce biogas. The straw is available in large quantities at a central site at low cost.

4530 **(SAND—82-7069) Development of a building block design of modular photovoltaic concentrator array fields.** Carmichael, D.C.; Alexander, G.; Noel, G.T.; Scurlock, L.D.; Huss, W.R.; Stickford, G.H. (Battelle Columbus Labs., OH (USA)). Aug 1983. Contract AC04-76DP00789. 186p. NTIS, PC A09/MF A01. Order Number DE84003917.

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To reduce the balance-of-system (BOS) costs and site-specific design costs for photovoltaic concentrator array fields, a modular Building Block design has been developed for installing array fields of each of two available concentrator collectors. The array-field subsystems and requirements incorporated in the design analyses include site preparation, foundations, electrical wiring, grounding, lightning protection, electromagnetic interference provisions, and tracking and controls. The Building Block designs developed minimize these array-field BOS costs and serve as standardized units to be used in multiples to construct array fields of various sizes. The detailed drawings and construction specifications prepared for the designs require only minimal design modification and cost for adaption to a specific site and application. The two concentrator collectors for which the modular array-field designs were developed are the linear-focus Fresnel-lens array manufactured by E-Systems, Inc., and the point-focus Fresnel-lens array manufactured by Martin Marietta Aerospace Corporation. Both designs are two-axis tracking and passively cooled. The developed Building Block designs are immediately applicable and reduce the array-field BOS costs and site-specific design costs to a fraction of those experienced in previous installations. The estimated array-field BOS costs (in 1982 dollars) using these modular designs are $0.78/W for the modular field based on the E-Systems array and $1.18/W for the modular field based on the Martin-Marietta array.

4531 **(SAND—83-7022) Design and development of low cost photovoltaic concentrator modules.** (Applied Solar Energy Corp., City of Industry, CA (USA)). Nov 1983. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01. Order Number DE84003150.

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During this contract, concentrator cell and modules were designed and built. A total of four modules was fabricated and tested. Three of these modules were delivered to Sandia National Labs., Albuquerque, New Mexico, for testing. The fourth module was retained at Applied Solar Energy Corporation for characterization study. The module and components were designed specifically for future high volume production and the use of automated equipment. The module meets the requirements for cost effectiveness and performance.

4532 **(SERI/PR—212-1864) Solid state photovoltaic research branch. Annual report, FY 1982.** (Solar Energy Research Inst., Golden, CO (USA)). Sep 1983. Contract AC02-77CH00178. 130p. NTIS, PC A07/MF A01. Order Number DE84000022.

This report summarizes the progress of the Solid State Photovoltaics Research Branch of the Solar Energy Research Institute from 1 October 1981 through 30 September 1982. There are six technical sections in the report covering the major areas of in-house photovoltaic research: Semiconductor Crystal Growth and Device Research, Material Preparation and Purification, Solid State Theory, Amorphous Materials, Thin-Film Compound Semiconductor Solar Cells, and High-Efficiency Multijunction Solar Cells. Each section of the report (except the Thin-Film Compound Semiconductor Section) was authored by the group leader principally in charge of the work. The task in each case was to explain the purpose and major accomplishments of the work in the context of the overall goals of the National Photovoltaics Program. A list of publications is provided at the end of each section.

4533 **(SERI/TP—234-1942) Biomass electrochemistry.** Chum, H.L. (Solar Energy Research Inst., Golden, CO (USA)). Oct 1983. Contract AC02-83CH10093. 5p. (CONF-8304135—1). NTIS, PC A02/MF A01. Order Number DE84000020.

From Solar and biomass energy workshop; Atlanta, GA, USA (26 Apr 1983).

The research objectives are to select the most relevant biomass-derived substrates which can benefit from electrochemical processing, improving the economics of fuel production from biomass sources. Electrochemical processing is being applied to biomass and derived materials to (1) upgrade their energy content, thereby generating fuels and fuel additives (octane or cetane boosters); (2) generate petrochemical substitutes from renewable resources; (3) increase the reactivity and value of the lignin fraction of the wood for a variety of applications of the polymeric materials, therefore generating alternative patterns of utilization of this by-product that can lead to an overall favorable economics of fuel production from biomass sources; and (4) investigate innovative ways of separation of fermentation substrates for subsequent electrochemical processing. We have completed functional group characterization, infrared spectroscopy, ^{1}H and ^{13}C nuclear magnetic resonance analyses (90 MHz instrument), and molecular weight distribution of the ethanol-extracted explosively-depressurized aspen lignin (EEEDAL). We have also submitted EEEDAL to electrolysis at constant potential -2.6 V vs Ag/AgCl reference electrode on mercury cathodes in methanol and observed the reduction of carbonyl groups as well as cleavage of side chains in the lignin molecules. The reduced materials have also been characterized. We plan to correlate structure of these well-characterized materials with the properties of the polymers. Replacing phenol with the lignin-derived materials in a thermosetting resin is one possible application.

4534 **(SERI/TR—8041-1-T1) Polymer((SN)/sub x/)-semiconductor junctions for solar-cell applications. Final report, September 15, 1979-March 31, 1981.** Harris, J.S.; Cohen, M.J.; Manasevit, H.M.; Zehr, S.W. (Rockwell International Corp., Golden, CO (USA)). Oct 1983. Contract AC02-77CH00178. 32p. NTIS, PC A03/MF A01. Order Number DE84002807.

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We have undertaken a study of the use of polymer-semiconductor junctions in solar cell applications. The polymer material of interest is polymeric sulfur-nitride, (SN)/sub x/, and its derivative $(SNBr_{0.4})_x$. $(SN)_x$ is the first example of a metallic polymer. It exhibits both metallic electronic and optical properties. In the molecule chain direction, its room temperature resistivity is as low as 3×10^{-4} Ω-cm, and its reflectance spectrum contains a plasma edge in the visible resulting in a golden appearance. In addition, (SN)/sub x/ films on semiconductor substrates have interfacial properties of interest for solar cell applications. In particular, preliminary electrical measurements indicate that the barriers formed by (SN)/sub x/ on a wide range of semiconductors are higher than those formed by any elemental metal. In our laboratory, we have fabricated the first solar cell whose junction was formed by a polymer-semiconductor interface. Open circuit voltages, $V_{oc} > 0.7$ V, have been observed on such cells consisting of a thin film of (SN)/sub x/ deposited on GaAs. This is an enhancement of more than 40% over the V/sub oc/ commonly measured with metal-GaAs solar cells. In addition, (SN)/sub x/ doped with bromine is transparent to almost the entire solar spectrum and should thus result in enhanced short circuit photo currents. Finally, the cost of (SN)/sub x/ is considerably lower than that of the precious metals commonly used in Schottky barrier solar cell fabrication. We present the background for and results of a study of the barrier height enhancement in polymer-semiconductor junctions and their potential application to reliable, low cost, high efficiency solar cells.

4535 **(TENRAC/EDF—112) Production potential of biomass feedstocks. Final report.** Goodin, J.R.; Newton, R.J. (Texas Tech Univ., Lubbock (USA); Texas A and M Univ., College Station (USA)). 31 Aug 1983. 77p. NTIS, PC A05/MF A01. Order Number DE84900408.

This final report summarizes biomass research on unconventional plants utilizing the concept that semi-arid lands may be advantageous and unique for biomass production because there would be little competition for irrigation water and land areas traditionally used for food and fiber production. The objectives are to: (1) evaluate the establishment and productivity potential of plant species in west Texas as influenced by rainfall, temperature and minimum cultural practices; and (2) accurately assess the present distribution and acreages inhabited by the four candidates in west Texas as well as the soil, geographical and climatic factors which govern their adaptation; and (3) provide productivity data in order to make adequate economic and sociological assessments of biomass production in west Texas. Seedlings of four biomass plant species originally screened from 2900 potential species have been established in a greenhouse and transplants of saltbush (Atriplex canescens), Johnsongrass (Sorghum halepense), kochia (Kochia scoparia), and mesquite (Prosopis glandulosa) have been planted at Brady, Big Lake, El Paso and Lubbock. Saltbush seedlings have also been established at Pecos. 35 references, 12 figures, 21 tables.

4536 **Photochemical storage potential of azobenzenes.** Olmsted, J. III; Lawrence, J.; Yee, G.G. (California State Univ., Fullerton). *Solar Energy;* **30**: 271-274(1983). Contract FG02-79ER10546.

The potential for storage of solar energy using photochemical trans-cis isomerizations of substituted azobenzenes has been studied. Polar substituents are found to red-shift the pi-pi* absorption spectrum of these compounds without destroying the endothermicity of the photoisomerization. Highly red-shifted compounds such as azonaphthalenes revert thermally to the trans isomer within seconds. Methyl orange has the most favorable energy storage potential of the compounds studied and has a storage efficiency of 16 percent for 436 nm irradiation and 2 percent for AM-1 isolation. Because of limited solubilities and rapid thermal reversion rates in polar solvents, it is concluded that azobenzenes are not favorable compounds for photochemical solar energy storage.

1406 Photovoltaic Power Systems

REFER ALSO TO CITATION(S) 4530, 4861

1407 Solar Thermal Power Systems

4537 **(DOE/DP/00789—T25) IEA Small Solar Power Systems Project: operation status report.** (Sandia National Labs., Livermore, CA (USA); Compania Sevillana de Electricidad, S.A., Madrid (Spain)). Sep 1983. Contract AC04-76DP00789. 21p. NTIS, PC A02/MF A01. Order Number DE84001821.

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The status of the operation of the IEA Small Solar Power Systems Project is reported for the period from January 1, 1983 to August 31, 1983. Included are reports of new hardware activities as given by the installation of both the advanced sodium receiver in the central receiver system and a 3rd collector field in the distributed collector system. (LEW)

4538 **(DOE/DP/00789—T26) Plant operation report. Daily evaluation summary.** (Sandia National Labs., Livermore, CA (USA); Compania Sevillana de Electricidad, S.A., Madrid (Spain)). Jul 1983. Contract AC04-76DP00789. 122p. NTIS, PC A06. Order Number DE84001818.

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The operation and maintenance of the IEA Small Solar Power Systems Project are reported, giving plant highlights, statistics, and cost data. The system includes both a distributed collector system and a central receiver system, for which monthly status data are given. (LEW)

4539 **(DOE/ET/20195—T4) Advanced thermal-energy-storage concept definition study for solar Brayton power plants. Volume IV. Solar power plant operation analysis computer program. Final technical report, July 1, 1976-December 31, 1976.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). [nd]. Contract AC03-76ET20195. 190p. NTIS, PC A09/MF A01. Order Number DE84002577.

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This document describes the computer program used to simulate the operation of the high temperature gas-cooled solar power plant. The program was used to assess the interrelations of plant components as opposed to the design of the individual elements. The model estimates the effectiveness of the Brayton cycle solar power plant on an hourly, daily and yearly basis. Herein is a description of the program and how the program is used including inputs, outputs and operating instructions.

4540 **(ORNL/TM—7287) Assessment of Rankine cycle heat engines for small solar power applications.** Meador, J.T. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 170p. NTIS, PC A08/MF A01. Order Number DE84002981.

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Performance evaluations of both ideal and actual Organic Rankine Cycles (ORC) and Steam Rankine Cycles (SRC) are made for systems, either available or being developed, that may be candidates in Solar Total Energy Systems (STES). Many organic fluids and turbines (or expanders), especially designed for ORCs, are being used in various current development programs. Only a few representative ORCs are evaluated. Some of the SRCs used with relatively small commercially available steam expanders are also evaluated. Most of the near term development projects of a STES probably will be relatively small, dispersed power, community size installations; therefore the electrical power outputs included range from 200 kW to 10 MW, with maximum cycle temperatures of 482°C (900°F). Some basic Rankine cycle efficiencies, without recuperation, resuperheating or feedwater heating, are evaluated and compared to Carnot cycle efficiencies when operating between the same limiting temperatures. The thermodynamic processes of a Toluene-ORC and a SRC are studied, including both isentropic (ideal) and actual expansions. Some actual organic and steam Rankine cycle efficiencies are compared to the criterion curves. Some estimates are also make of the potential improvements in performance due to addition of a recuperative heat exchanger and feedwater heaters for the ORCs and the SRCs, respectively.

4541 **(SAND—82-8036) Wind load and life-cycle testing of second generation heliostats.** Rorke, W.S. Jr. (Sandia National Labs., Albuquerque, NM (USA)). Nov 1983. Contract AC04-76DP00789. 163p. NTIS, PC A08/MF A01. Order Number DE84003333.

As technical manager of the Second Generation Heliostat development contracts for the Department of Energy, Sandia National Laboratories has evaluated four heliostat designs. The evaluation of the heliostats included the life-cycling and simulated wind load testing of prototype heliostats and foundations. All of the heliostats had minor problems during this testing; as a result, specific design improvements were identified for each drive mechanism and for two of the four foundations.

1409 Solar Thermal Utilization

REFER ALSO TO CITATION(S) 4507, 4516, 4540, 4861, 4875

4542 **(DOE/CS/30220—T1) Determination of the thermal stability of organic working fluids used in Rankine-cycle power systems for solar cooling. Program period, October 1, 1980-December 1, 1982.** Morgan, D.; Mills, K.; Zakak, A.; Reinhold, V.; Carr, S. (Thermo Electron Corp., Waltham, MA (USA); Harvard Medical School, Boston, MA (USA)). 1 Oct 1983. Contract AC03-80CS30220. 236p. NTIS, PC A11/MF A01. Order Number DE84001862.

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Refrigerants R-11 and R-113 were tested in dynamic loops simulating Rankine-cycle power systems for solar cooling applications. Each fluid was tested with and without Zephron oil utilizing four loops. The goal of the testing was to determine the maximum boiler outlet temperature at which these fluids could be used for long-life systems in order to maximize performance. Acceptable temperature limits established were: R-11/Zephron Oil, <250°F; R-11, 300°F; R-113, >350°F; and R-113/Zephron Oil, >330°F.

4543 **(DOE/R6/10958—T1) Monitoring of thermal mass performance, Wathen residence, Aledo, Texas. Final progress report.** Austin, W.S. (Austin (William S.), Fort Worth, TX (USA)). 6 Jul 1982. Contract FG46-79R610958. 55p. NTIS, PC A04/MF A01. Order Number DE84003134.

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The design, construction, and monitoring of an earth sheltered, passive-solar heated home with rock bed heat storage are described. Problems with the data recording equipment are detailed. (MHR)

4544 **(DOE/R6/12026—T1) Demonstration of a retrofit solar heating system on the Jemez Pueblo Civic Center. Final report, February 25, 1980-January 31, 1983.** Edgel, W.R. (New Mexico Univ., Albuquerque (USA). Engineering Research Inst.). Feb 1983. Contract FG46-80R612026. 53p. NTIS, PC A04/MF A01. Order Number DE84003540.

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This project consisted of designing and constructing thermal envelope improvements, a retrofit Trombe wall, and a domestic hot water preheater on the Jemez pueblo Civic Center, an 11,000-square foot masonry building which houses a gymnasium, classrooms, and the tribal offices. The purpose of this project was to demonstrate the applicability of retrofit solar heating systems to large buildings owned by local governments in remote areas of the state. preliminary estimates indicated that the proposed retrofit installation would reduce the fuel consumption of the subject building substantially. After construction, the fuel consumption of the building was monitored to measure the actual fuel and cost savings, which are projected to be nearly 50%.

4545 **(EUR—8219-EN) Italian Pilot Test Facility: design, construction, and first period of operation.** Grassi, L.; Cocilovo, M.; Triglia, A. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 1983. 115p. European Community Information Service, 2100 M Street, NW, Suite 707, Washington, DC 20037.

This report deals with the design, construction and first period of operation of the Italian PTF (Pilot Test Facility). The work described has been carried out by Phoebus on Behalf of ENEL (National Board for Electric Energy) as part of a project of the solar heating and cooling programme of the Commission of the European Communities. In order to validate over a wide range of climatic conditions simulation models for solar space heating in dwellings, the Commission decided to have eight PTFs built in eight countries of the European Community, each PTF consisting of a reference Solar System 1, identical for all the participants, and a Solar System 2, designed by each participant so as to fit the specific climatic conditions and living habits of the country involved. After a description of Solar System 1, the report treats of the national Solar System 2, whose peculiar feature is the provision of space cooling during summertime, by means of an absorption chiller, supplied by high performance vacuum tube collectors. The data acquisition and central control system is then described; finally the results are given of the first tests on Solar System 1 and conclusions are drawn from the work so far carried out.

4546 **(NP—4900197) Effects of solar water heating systems on the electric utility. Residential Conservation Demonstration Program.** Belser, T.L. (CH2M Hill, Gainesville, FL (USA)). Oct 1982. 101p. NTIS, PC A06/MF A01. Order Number DE84900197.

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This report presents the results of a residential demonstration project relating to the effects of solar water heating systems with electric back-up on the electric utilities. The project, which was funded by the Florida Public Service Commission, was conducted in Gainesville, Florida, where 22 customers of the Gainesville Regional Utilities system took part in the study. Additional funding for a portion of Gainesville Regional Utilities' participation in the project was provided by the City of Gainesville. The study group was comprised of 10 participants with conventional electric water heaters, 6 participants with existing solar water heaters, and 6 participants who purchased new solar water heaters (with electric back-up) which were designed and installed with strong emphasis placed on performance and quality. The participants' water heating systems were monitored at 15-minute intervals to determine: hot water use, net energy content of hot water, and electrical consumption. The study also involved investigating the potential use of a Transient System Simulation Program (TRNSYS) for solar water heaters to predict the electric back-up requirements in order to provide a means of forecasting coincident peaks with the electric utility. Study results show that solar water heaters with electric back-up contribute less to the utility's coincident demand than do conventional electric water heaters. While both groups of solar participants had lower electric consumption per gallon than did the conventional electric (CELE) participants, the new solar (NSOL) water heating systems were much more effective than the existing solar (ESOL) water heating systems. The major contributing factors to this difference were better system design and overall quality of workmanship. Use of the TRNSYS simulation program to forecast coincident peaks did not provide the desired reliable results.

4547 **(NP—4900202) Passive-solar design studies. Residential Conservation Demonstration Program.** Ingley, H.A. (Florida Public Service Commission, Tallahassee (USA)). 1982. 133p. NTIS, PC A07/MF A01. Order Number DE84900202.

This report presents the results of a residential demonstration project relating to passive solar retrofits. The project, which was funded by the Florida Public Service Commission, was conducted in Gainesville, Florida, utilizing two research residences located at the University of Florida's Energy Research and Education Park (EREP) and two residences located in a suburban neighborhood of Gainesville. These latter homes were used as a control group. The two EREP homes were subsequently retrofitted with passive solar energy conservation measures. Data were collected over a period of time to investigate the effects of these retrofits on air conditioning energy use. The study also involved a computer analysis of several retrofits including those adapted to the research residences. Several cost analysis techniques were used to evaluate the cost effectiveness of the retrofits. Experimental study results illustrate the effects of the various passive solar cooling retrofits on the EREP homes' energy use. Exterior window shading and the whole-house fan yielded standard savings in energy. The earth berm used on one of the homes appeared to delay the electric peak associated with cooling. Problems resulted with the use of some of these retrofits, e.g., high humidities were noted with the whole-house fan, and these were documented. The computer energy use model (UF/SAM) proved to be a very effective tool for evaluating the impact of several passive solar cooling retrofits on residential energy use. Several combinations of retrofits were analyzed and their cost effectiveness was compared.

15 GEOTHERMAL ENERGY

1502 Geology And Hydrology Of Geothermal Systems

4548 **Geological, geophysical, and thermal characteristics of the Salton Sea geothermal field, California.** Younker, L.W.; Kasameyer, P.W.; Tewhey, J.D. (Lawrence Livermore National Lab., CA). *Journal of Volcanology and Geothermal Research;* **12**: No. 3-4, 221-258(May 1982). Contract W-7405-ENG-48.

The Salton Sea Geothermal Field is the largest water-dominanted geothermal field in the Salton Trough in Southern California. Within the trough, local zones of extension among active right-stepping right-lateral strike-slip faults allow mantle-derived magmas to intrude the sedimentary sequence. The intrusions serve as heat sources to drive hydrothermal systems. The sediments are relatively undeformed and can be divided into three categories as a function of depth: (1) low-permeability cap rock, (2) upper reservoir rocks consisting of sandstones, siltstones, and shales that were subject to minor alterations, and (3) lower reservoir rocks that were extensively altered. Because of the alteration, intergranular porosity and permeability are reduced with depth. Field permeability is enhanced by renewable fractures, i.e., fractures that can be reactivated by faulting or natural hydraulic fracturing subsequent to being sealed by mineral deposition. In the central portion of the field, temperature gradients are high near the surface and lower below 700 m. At the margin of the field, a narrow transition region, with a low near-surface gradient and an increasing gradient at greater depths, separates the high temperature resource from areas of normal regional gradient. Geophysical and geochemical evidence suggest that vertical convective motion in the reservoir beneath the thermal cap is confined to small units, and small-scale convection is superimposed on large-scale lateral flow of pore fluid. A simple hydrothermal model is supported by interpreting the combined geological, geophysical, and thermal data. In the model, heat is transferred from an area of intrusion by lateral spreading of hot water in a reservoir beneath an impermeable cap rock.

1503 Geothermal Exploration And Exploration Technology

4549 **(USGS-OFR—0-82-4) Geothermal gradient data, 1981.** Blackwell, D.D.; Black, G.L.; Priest, G.R. (Oregon State Dept. of Geology and Mineral Industries, Portland (USA)). 1982. Contract FC07-79ID12044;FC07-79ET27220. 444p. NTIS, PC A19/MF A01. Order Number DE84003666.

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Geothermal gradient data are tabulated for Oregon by township from north to south.

4550 **(USGS-OFR—80-737) Chemical and isotopic data for water from thermal springs and wells of Oregon.** Mariner, R.H.; Swanson, J.R.; Orris, G.J.; Presser, T.S.; Evans, W.C. (Geological Survey, Menlo Park, CA (USA)). Jan 1981. 52p. NTIS, PC A04. Order Number DE84900278.

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The thermal springs of Oregon range in composition from dilute $NaHCO_3$ waters to moderately saline CO_2-charged NaCl-$NaHCO_3$ waters. Most of the thermal springs are located in southeastern or southcentral Oregon, with a few in northeastern Oregon and near the contact of the Western Cascades with the High Cascades. Thermal springs in the central and northern parts of the Cascades generally issue moderately saline NaCl waters. Farther south in the Cascades, the thermal waters are high in CO_2 as well as chloride. Most thermal springs in northeastern Oregon issue dilute $NaHCO_3$ waters of high pH (>8.5). These waters are similar to the thermal waters which issue from the Idaho batholith, farther east. Most of the remaining thermal waters are Na mixed-anion waters. Based on the chemical geothermometers, Mickey Srpings, Hot Borax Lake, Alvord Hot Springs, Neal Hot Springs, Vale Hot Springs, Crump Well, Hunters (Lakeview) Hot Springs, and perhaps some of the springs in the Cascades are associated with the highest temperature systems (>150°C).

1506 Environmental Aspects And Waste Disposal

4551 **(LBL—16574) Pressure transient method for front tracking.** Benson, S.M.; Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (USA)). Aug 1983. Contract AC03-76SF00098. 22p. (CONF-8310121—6). NTIS, PC A02/MF A01. Order Number DE84002913.

From SPE annual technical conference; San Francisco, CA, USA (5 Oct 1983).

A pressure transient technique for tracking the advance of cold water fronts during water flooding and goethermal injection operations has been developed. The technique is based on the concept that the steady state pressure buildup in the reservoir region inside the front can be calculated by a fluid skin factor. By analyzing successive pressure falloff tests, the advance of the front in the reservoir can be monitored. The validity of the methods is demonstrated by application to three numerically simulated data sets, a nonisothermal step-rate injection test, a series of pressure falloffs in a multilayered reservoir, and a series of pressure falloff tests in a water flooded oil reservoir.

1508 Geothermal Power Plants

4552 **(DOE/CS/30674—2) Geothermal power plant R and D: an analysis of cost-performance tradeoffs and the Heber Binary-Cycle Demonstration Project.** Cassel, T.A.V.; Amundsen, C.B.; Blair, P.D. (Technecon Analytic Research, Inc., Philadelphia, PA (USA)). 30 Jun 1983. Contract AC02-81CS30674. 174p. NTIS, PC A08/MF A01. Order Number DE84003171.

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A study of advancements in power plant designs for use at geothermal resources in the low to moderate (300 to 400F) temperature range is reported. In 3 case studies, the benefits of R and D to achieve these advancements are evaluated in terms of expected increases in installed geothermal generating capacity over the next 2 decades. A parametric sensitivity study is discussed which analyzes differential power development for combinations of power plant efficiency and capitol cost. Affordable tradeoffs between plant performance and capital costs are illustrated. The independent review and analysis of the expected costs of construction, operation and maintenance of the Heber Binary Cycle Geothermal Power Demonstration Plant are described. Included in this assessment is an analysis of each of the major cost components of the project, including (1) construction cost, (2) well field development costs, (3) fluid purchase costs, and (4) well field and power plant operation and maintenance costs. The total cost of power generated from the Heber Plant (in terms of mills per kWh) is then compared to the cost of power from alternative fossil-fueled base load units. Also evaluated are the provisions of both: (a) the Cooperative Agreement between the federal government and San Diego Gas and Electric (SDG and E); and (b) the Geothermal Heat Sales Contract with Union Oil Company.

4553 **(DOE/R6/12017—T1) Rankine cycle generators using geothermal fluids. Final progress report.** (Campbell (D.A.), Silver City, NM (USA)). 1981. Contract FG46-80R612017. 18p. NTIS, PC A02/MF A01. Order Number DE84003159.

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The Rankine Cycle generator was delivered and installed at Gila Hot Springs. Trial runs were made at that time, using Freon 12 as the expansion fluid. These tests showed that the boiler capacity was inadequate. It could not extract enough heat to generate sufficient volumes of Freon gas at the heat and pressure necessary to operate the system at an acceptable level. Increasing and decreasing the flow of hot water had a direct influence on efficiency, but it was not a linear relationship. Added amounts of hot water increased the power very little, but raised the water temperature at the discharge point. This implied that the heat exchange capacity of the boiler was saturated. The reverse was found in the condenser system. There was little increase in pressure of the condenser when we switched from static to run mode. Efficiency was maintained even when the cold water flow was reduced as much as 40%. The tests using Freon 12 resulted in the conclusion that the boiler volume needs to be increased and/or the configuration changed to radically increase its efficiency.

1509 Geothermal Engineering

4554 **(NZERDC—95) Utilisation of geothermal energy: two phase flow studies.** Freeston, D.H.; Lee, K.C.; Hole, H. (New Zealand Energy Research and Development Committee, Auckland). Sep 1983. 34p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE84900366.

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The pressure drop and flow regime of a two phase water/steam mixture from a geothermal well flowing in a pipeline have been experimentally studied. A test loop was built on the Wairakei geothermal field at Well 207. The test loop included straight, horizontal and inclined sections as well as a number of fittings, bends, tees, etc., for which pressure drop data was obtained. The data was used to establish that the separated flow model, with a correlation for void fraction due to Harrison (1977), could successfully predict the pressure drop in a horizontal pipe operating in the annular flow regime. The flow pattern map of Mandhane et.al. (1974) is believed to be adequate for establishing the flow regime in a pipeline carrying a geothermal two phase fluid. Pressure drop information in terms of an equivalent length of straight pipe is included for U and S 90° bend combinations, a sudden contraction of area ratio 4:1, a long radius (R/D=90) bend, a 90° elbow and mitred bend, and a 45° S bend. Data for a tee with variable take off flows is also included. Inclined pipe pressure drop data has been collected, but to date has not been correlated successfully. The report includes a brief discussion of the prediction methods available and demonstrates, with pressure drop measurements taken at a Broadlands two phase line, that the separated model is satisfactory. The results from an air/water experiment are used to question the advisability of using such data for a steam/water design.

4555 **(SAND—83-7435) Development of a new family of cemented carbides for geothermal drilling. Final report.** Rowcliff, D.J. (SRI International, Menlo Park, CA (USA)). Oct 1983. Contract AC04-76DP00789. 48p. NTIS, PC A03/MF A01. Order Number DE84003148.

The contractor fabricated samples of cemented carbides based on tantalum carbide and niobium carbide with cobalt and nickel binders. These materials were evaluated for use as rock-bit inserts in geothermal drilling. Carbon content in the niobium carbide (NbC/sub x/) and the tantalum carbide (TaC/sub x/) was varied (x is 0.83 to 1.0) and the effect of these changes on the carbides' mechanical properties was examined. Hardness, toughness, and abrasive wear resistance of the new materials were measured and compared to properties of tungsten carbide grades used in rock-bit inserts.

4556 **Application of numerical methods for predicting energy transport in earth contact systems.** MacArthur, J.W.; Meixel, G.D.; Shen, L.S. (Honeywell Technology Strategy Center, 1700 West Highway 36, Saint Paul, Minnesota 55113). *Applied Energy;* **13**: No. 2, 121-154(Feb 1983). Contract AC03-80SF11508.

Methods for analyzing conductive heat flow with applications to underground earth contact systems are reviewed. A discussion and comparison of both the finite difference and finite element methods are presented. The effect of domain discretisation on accuracy for both methods is presented. One- and two-dimensional models are derived and used to solve selected problems. The results for various discretisation domains are compared and contrasted. The application of both the finite difference and finite element approaches to the analysis of heat transfers in an underground building is given. Recommendations are made to aid in the selection of the numerical techniques that are the most appropriate for analyzing conductive heat flow problems. Finally, a statement is made on the analysis of the three-dimensional heat and moisture transport problem associated with underground earth contact systems.

1510 Direct Energy Utilization

REFER ALSO TO CITATION(S) 4875

4557 **(DOE/R6/10974—T1) Lightning dock geothermal space heating project, Lightning Dock KGRA, New Mexico. Final report.** McCants, T.W. (McCants (Thomas W.), Animas, NM (USA)). 1980. Contract FG46-79R610974. 13p. NTIS, PC A02/MF A01. Order Number DE84003450.

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The proposed project was to take the existing geothermal greenhouse and home heating systems, which consisted of pumping geothermal water and steam through passive steam heaters, and convert the systems to one using modern heat exchange units. It was proposed to complete the existing unfinished, re-inforced glass side wall, wood framed structure, as a nursery lath house, the purpose of which would be to use geothermal water in implementing university concepts on the advantages of bottom heat to establish hardy root systems in nursery and bedding plants. The use of this framework was abandoned in favor of erecting new structures for the proposed purpose. The final project of the proposal was the establishment of a drip irrigation system, to an area just west of the existing greenhouse and within feet of the geothermal well. Through this drip irrigation system geothermal water would be pumped, to prevent killing spring frosts. The purpose of this area of the proposal is to increase the potential use of existing geothermal waters of the Lightning Dock KGRA, in opening a new geothermal agri-industry which is economically feasible for the area and would be extremely energy efficient.

4558 **(DOE/R6/10986—T1) Heating and cooling of municipal buildings with waste heat from ground water.** Morgan, D.S.; Hochgraf, J. (Halff (Albert H.) Associates, Inc., Dallas, TX (USA)). Oct 1980. Contract FG46-79R610986. 70p. NTIS, PC A04/MF A01. Order Number DE84003539.

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The feasibility of using waste heat from municipal water wells to replace natural gas for heating of the City Hall, Fire Station, and Community Hall in Wilmer, Texas was studied. At present, the 120°F well water is cooled by dissipating the excess heat through evaporative cooling towers before entering the distribution system. The objective of the study was to determine the pumping cycle of the well and determine the amount of available heat from the water for a specified period. This data were correlated with the heating and cooling demand of the City's buildings, and a conceptual heat recovery system will be prepared. The system will use part or all of the excess heat from the water to heat the buildings, thereby eliminating the use of natural gas. The proposed geothermal retrofit of the existing natural gas heating system is not economical because the savings in natural gas does not offset the capital cost of the new equipment and the annual operating and maintenance costs. The fuel savings and power costs are a virtual trade-off over the 25-year period. The installation and operation of the system was estimated to cost $105,000 for 25 years which is an unamortized expense. In conclusion, retrofitting the City of Wilmer's municipal buildings is not feasible based on the economic analysis and fiscal projections as presented.

4559 **(DOE/R6/10987—T1) Geothermally heated Chamber of Commerce offices at Marlin, Texas. Final report.** (Marlin Chamber of Commerce, TX (USA)). 31 Jul 1981. Contract FG46-79R610987. 25p. NTIS, PC A02/MF A01. Order Number DE84003130.

The use of an existing, low temperature, geothermal resource to heat the Chamber of Commerce offices in Marlin, Texas is described. A secondary purpose of the project is to attract new industries and businesses to Marlin via this alternate energy showpiece demonstration of a simple and practical application of Texas' low temperature geothermal resource.

1520 Geothermal Data And Theory

REFER ALSO TO CITATION(S) 4550

17 WIND ENERGY

1706 Wind Energy Engineering

REFER ALSO TO CITATION(S) 4507

4560 **(DOE/R6/10962—T1) Windpowered irrigation system for small pecan orchards. Final report.** Goulden, D.R. (Goulden (Darrell R.), Yukon, OK (USA)). 2 Jun 1981. Contract FG46-79R610962. 16p. NTIS, PC A02/MF A01. Order Number DE84003545.

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A solution to the high installation and maintenance costs for small-orchard irrigation lies in the use of the windmill and a gravity-flow distribution system. Applying windpower for pumping and distributing water for irrigation of small pecan orchards is now economically feasible in many areas where pecans are grown. Because of its constant, moderate wind speeds, the central Oklahoma region lends itself well to such a system.

4561 **(DOE/R6/10997—T1) Wind-powered heat pump experiment.** Regan, D.C. (San Jacinto Coll., Pasadena, TX (USA)). May 1983. Contract FG46-79R610997. 54p. NTIS, PC A04/MF A01. Order Number DE84003141.

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The work described in this report was completed in two parts. The first part was an evaluation of an automotive type freon compressor, which demonstrated that such a device could be operated at slow speeds (600 to 1200 rpm) and still produce useful amounts of heat transfer. This device was evaluated and output measured by temperature measurements made on tanks of water in which the condenser and evaporator coils were immersed. The second portion of the project was to have been a demonstration using a wind turbine as the motive power and construction of a full scale system. However, after several different attempts to construct a working system, the work had to be terminated because the device to convert the wind power to mechanical power for turning the compressor coud never be successfully operated for any extended period of time. A description of the work completed and the reasons for the failure of the concept are delineated.

4562 **(DOE/R6/12029—T1) Wind power for the Creek Nation. Final report.** (Muscogee (Creek) Nation, Okmulgee, OK (USA). Div. of Tribal Affairs). 1982. Contract FG46-81R612029. 5p. NTIS, PC A02/MF A01. Order Number DE84003124.

An Enertech 1800 horizontal-axis wind powered electric generator was purchased and interphased with the electric utility system provided to the Creek Nation by the Public Service Company of Oklahoma. Objectives of the work include: to determine the economic feasibility of wind power for the Creek Nation region; to educate the Creek Nation and other Indian tribes about the potential use of wind power; and to accumulate valuable climatic data

through an on-site wind survey at a height of 60' over a long period of time. (LEW)

4563 (DOE/R6/12049—T1) Design of a wind-driven mechanical refrigeration unit. O'Hara, J.C. (O'Hara (James C.), Corpus Christi, TX (USA)). Apr 1982. Contract FG46-80R612049. 65p. NTIS, PC A04/MF A01. Order Number DE84003157.

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A design is presented for a wind driven mechanical refrigeration system which will provide, on the average, approximately 1/4 horsepower cooling capacity from wind conditions encountered in South Texas. The windmill has a two blade, ten foot diameter propeller and will remove approximately 2000 Btu/hour of heat from a space under conditions of evaporator and condenser temperatures of 20°F and 120°F, respectively. The average wind velocity in south Texas is 11 to 12 mph. The system consists of a custom-built fiberglass propeller, a power transmission train made-up from standard parts, commercially available refrigeration compressor and expansion valve and custom built gravity type evaporator and condenser. There do not appear to be any unsurmountable technical problems to be worked out in the prototype testing phase except perhaps for the speed limiting device. This device may require considerable development. A cost estimate is presented for manufacturing and marketing the unit based on total sales of 500 units. The selling price per unit is estimated to be $3995.00. This price is considered to be too high for the system to be competitive in areas where electric power is readily available even considering the current tax advantage available to the purchaser. However, the system might be attractive for remote areas or for energy conservation reasons.

4564 (DOE/R6/12060—T1) Demonstration project: wind turbines for municipal water pumping. Nelson, V. (West Texas State Univ., Canyon (USA). Alternative Energy Inst.). Aug 1982. Contract FG46-80R612060. 25p. NTIS, PC A02/MF A01. Order Number DE84003142.

In 1979, personnel from Alternative Energy Institute (AEI) studied the feasibility of using wind power in the operation of the municipal water system for the City of Canyon, Texas (1). Predicted energy outputs from six different wind turbines were calculated from power curves and long term National Weather Service (NWS) data. The conclusions were that the cheaper wind turbines should payback in 10 years, with a displacement of 30 to 50 percent of the energy needed for pumping the water wells. A Carter 25 wind turbine should displace 45,000 kWh/year and feed back to the utility grid 30,000 kWh/year. On this basis, a proposal was submitted to Department of Energy (DOE)-Appropriate Energy Technology for two Carter 25 wind turbines, which would operate in the wind assist-electric mode. In October 1980, DOE awarded $31,800 for the project, and the wind turbines were installed in March 1981. The mode of operation and description of Carter 25's are given. Data are taken on energy produced and windspeeds. Results include energy fed back to the utility, predicted energy from measured windspeeds, and reliability of the wind turbines. An economic analysis indicates wind turbines are not cost effective at the present time for pumping water at the Canyon well field.

4565 (DOE/R6/12076—T1) Windpowered irrigation system for small farm applications. England, B. (England (Bill), Hawley, TX (USA)). 1982. Contract FG46-81R612076. 17p. NTIS, PC A02/MF A01. Order Number DE84000955.

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The overall purpose of the project was to conserve water on a small-scale truck patch vegetable gardening operation. The main thrust centered on improving water usage in the already-existing windmill/storage tank/house/farm pond setup. Most of the funds were spent on a trickle (drip) irrigation system linked into the existing wetup. Other areas improved were the farm pond itself, backup pumping for windmill and farm pond, and greywater reclamation. In spite of problems which had to be restudied and corrected, the project was an overall success both in terms of results and budget.

4566 (TENRAC/EDF—111) Use of wind power to assist in stripper (oil) well pumping. Gilmore, E.H. (West Texas State Univ., Canyon (USA). Alternative Energy Inst.). 31 Aug 1983. 47p. NTIS, PC A03/MF A01. Order Number DE84900427.

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Background information and project objectives are covered in this report. Project hardware - the wind turbine, its foundation, the instrumentation, etc. - is covered in considerable detail because the project is concerned with hardware performance as well as system performance. The site and its characteristics are described as are important details on the assembly and erection of the tower with the turbine on it. An operating log covering the period from January 1, 1982 through May 31, 1983 is provided in Appendix B and an energy production log in Appendix C. Appendix D provides considerable information on data collected in the periods when the turbine was operational and had no known problems. The test results are then presented which show operating costs that are presently too high to compete with local utility rates, but which will become more competitive if prices for electricity continue to escalate as they have in the last two or three years. It will be recommended that the project be continued with the wind turbine at its current site for another year. The several reasons for this recommendation will be presented and discussed at length.

20 ELECTRIC POWER ENGINEERING

2001 Power Plants And Power Generation

4567 Cogeneration. Belding, J. Cambridge, MA; The MIT Press (1982). 57p.

Cogeneration is the production of process heat from the waste energy of power-generating equipment or the generation of power from the fuel used for process heat. In plants needing both power and process heat, cogeneration is more efficient than satisfying the two needs separately (such as by buying power from a utility company and raising process steam on the site). Figures, tables, and unit self-tests are included.

2002 Environmental Aspects

REFER ALSO TO CITATION(S) 4335

4568 (N—8326183) Multidimensional programming methods for energy facility siting: Alternative approaches. Solomon, B.D.; Haynes, K.E. (West Virginia Univ., Morgantown (USA)). 1982. 17p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. of Energy Resource Management, Vol. 2 p 393-409 (SEE N83-26176 15-43).

The use of multidimensional optimization methods in solving power plant siting problems, which are characterized by several conflicting, noncommensurable objectives is addressed. After a discussion of data requirements and exclusionary site screening methods for bounding the decision space, classes of multiobjective and goal programming models are discussed in the context of finite site selection. Advantages and limitations of these approaches are highlighted and the linkage of multidimensional methods with the subjective, behavioral components of the power plant siting process is emphasized.

4569 Fort Peck-Havre transmission line project, Hill, Blaine, Phillips, Valley and McCone Counties, Montana. *EIS (Environmental Impact Statements);* **6**: No. 9, 9(Sep 1982).

Construction and operation of a 180-mile, 230-kilovlt (kV) transmission line between Fort Peck and Havre, Montana is proposed to provide a replacement for the 161-kV line that currently runs between the two cities. The new line would be carried on woodpole, H-frame structures. The existing 161-kV line would be removed, and the Richardson Coulee Substation would be relocated. Intermediate facilities to be improved would include the Fort Peck Switchyard and the Richardson Coulee, Malta, Harlem, and Havre substations.Construction of the line would commence in August 1983, and operation would commence in January 1986. The

expected life of the transmission system would be 100 years. Estimated cost of the project, in 1983 dollars, is $36.1 million. The project would upgrade an essential element of the Western Area Power Administration's electric power system and the Montana Power Company's interconnected transmission network. Continued electric service reliability would be improved, and safety conditions affecting personnel who maintain the line would be enhanced. Additional transmission capacity would be provided to accommodate future load growth, precluding the need for multiple transmission lines. The line would eleminate seven acres of productive land and create physical conflicts with present and future agricultural activities. The line would traverse areas characterized by concentrations of archaeological resources and cultural resources of importance to native Americans. Transmission structures could mar scenery in areas with historically significant architecture and would interfere with waterfowl.

2003 Power Transmission And Distribution

REFER ALSO TO CITATION(S) 5539

4570 **(CONF-8207101—) Ultra high voltage transmission technology Italy-USA joint workshop, July 26-28, 1982.** (Bonneville Power Administration, Portland, OR (USA); Ente Nazionale per l'Energia Elettrica, Milan (Italy)). 1982. 392p. NTIS, PC A17/MF A01. Order Number DE84001910.

From Italy/US joint ultra high voltage transmission technology workshop; Portland, OR, USA (25 Jul 1982).

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Twenty-five papers are presented in the following areas: electric field effects, overhead lines, substations and cables, and electric load modeling. One US DOE paper is processed separately. (DLC)

4571 **(DOE/ET/29661—2) Compressed gas insulated transmission: line trap development. Final report.** Perry, M.P.; Carlson, G.J. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center). Oct 1982. Contract AC01-76ET29661. 96p. NTIS, PC A05/MF A01. Order Number DE84002626.

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Goal is to develop a line trap compatible with gas-insulated conductors normally operating at 1200 kV (phase-to-phase) and 3000 A line current (5000 A maximum continuous current). A line trap (also called a wave-trap) basically consists of a series-connected inductor which must carry the full rated 60 Hz phase current. The inductance serves as a filter for higher frequency carrier signals (30 to 500 kHz) by establishing an enhanced impedance at the carrier frequency while allowing the 60 Hz to pass. The inductor may be parallel-tuned with a variety of tuning component options to further increase the blocking impedance at selected frequencies.

21 NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 4807

4572 **(INIS-mf—8415) Operation manual. Rules and regulations.** Krotil, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 38p. (CONF-8109220—23). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703302.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The present paper deals with function, concept and structure of Reactor Operation Manuals as an essential element in bringing man and machine in harmony.

4573 **(INIS-mf—8422) Operational experience, availability and reliability of nuclear power plants.** Kueffer, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 16p. (CONF-8109220—27). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703308.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

This lecture presents a survey on nuclear power production and plant performance in the Western World covering all reactor types and light-water reactors in particular and discusses key parameters such as load factors and non-availability analysis, outlines the main reasons for the reliable performance of Swiss nuclear power plants and explains the management function as applied at the Beznau Nuclear Power Station to ensure high power productivity and reliability.

4574 **(INIS-mf—8432) Special training of shift personnel.** Martin, H.D. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 27p. (CONF-8109220—24). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703303.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The first step of on-the-job training is practical observation phase in an operating Nuclear Plant, where the participants are assigned to shift work. The simulator training for operating personnel, for key personnel and, to some extent, also for maintenance personnel and specialists give the practical feeling for Nuclear Power Plant behaviour during normal and abnormal conditions. During the commissioning phase of the own Nuclear Power Plant, which is the most important practical training, the participants are integrated into the commissioning staff and assisted during their process of practical learning by special instructors. The preparation for the licensing exams is vitally important for shift personnel and special courses are provided after the first non-nuclear trial operation of the plant. Personnel training also includes performance of programmes and material for retraining, training of instructors and assistance in building up special training programmes and material as well as training centers.

4575 **(INIS-mf—8433) Special training of craftsmen for maintenance and repair.** Scholz, H.E. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 22p. (CONF-8109220—25). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703304.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The most important prerequisites for keeping nuclear power plants running safely and consistently are the reliable plant supervision and control by operators and shift engineers and its permanent servicing and maintenance as well as the performance of qualified repair work. Therefore, sophisticated training of qualified labour in the fields of mechanical engineering, electrical engineering and instrumentation and control is as important as of operators and shift engineers. The objectives of the relevant training measures for the personnel mentioned above are: Acquisition of solid basic skills in the respective professions, development of a broad background in how nuclear power plants are designed and function, gaining a sound insight into the working procedures in nuclear power plants, maintenance planning, duties and responsibilities of personnel involved, and acquiring thorough knowledge of the systems and its components, the assigned staff will be responsible for.

4576 **(INIS-mf—8434) Refresher courses.** Recker, M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 53p. (CONF-8109220—26). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703305.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

In order to keep the status of knowledge of the operating personnel of power plants on an equally high level, refresher training for this personnel has to be run periodically. In Germany, the method and scope of the refresher training is determined as requisition in the general direction of the Federal Minister of the Interior (Richtlinie des Bundesinnenministers). The target groups for the refresher training are the shift personnel and the specialists of the production department. In the first place, the refresher training should serve for increasing the availability and security of the plant. It will be described how, e.g., the training programs for the various groups can be structured. Furthermore, the application of a simulator as well as of accompanying material will be mentioned.

4577 **(INIS-mf—8438) Workshop on safety analysis reports and licensing procedures. Pt. 2.** Burkart, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 18p. (CONF-8109220—15). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703281.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The present paper deals with the document "Single Failure Concept-Principles for the Application of the Single Failure Criterion" approved by the Federal States Committee for Nuclear Energy (Federal Republic of Germany).

4578 **(INIS-mf—8440) Different types of staff to be trained.** Eyss, H.J. von. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 10p. (CONF-8109220—15). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703282.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The requirements to be applied to the personnel in nuclear power plants are outlined in article 7 of the Atomic Energy Act of the Federal Republic of Germany. Relative to the measures of requirements, one has to distinguish between the following two personnel groups: the responsible operating personnel and the subordinate personnel. The highest degree of requirements are put to the responsible operating personnel, including the station superintendant, operation- and other superintendants, the training officer, the health physicists, the shift supervisor and control room operators. They have to prove their requisite compentence, specified in a set of guidelines, before the authorities. Essential elements of the requisite competence of the operating personnel are their professional qualification, their safety-related knowledge, their abilities and their practical experience, which have to be gained - except the first one - essentially by plant-related training. For the subordinate operating personnel, i.e. all personnel in the plant not belonging to the responsible operating personnel, only necessary knowledge concerning safe operating of the plant, possible risks and safety measures to be applied, outlined in four subjects: fire protection, radiation protection, work safety and knowledge of the plant, is required.

4579 **(INIS-mf—8451) Quality assurance in Spain.** Villate, J. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 30p. (CONF-8009308—53). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703297.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

The first part of this lecture is devoted to present the energy program in Spain and the three generations of nuclear plants. The evolution of QA is outlined pointing out how IAEA Codes of Practice on QA is now a requirement and also how USA regulations, codes and standards have constituted, up to now, the main framework to develop QA activities in Spain. A general idea is given of the Spanish program of courses to qualify the personnel to be involved in QA tasks in nuclear power plants. Finally a general scheme is given, emphasizing the three main aspects: design, procurement and fabrication; construction (QA on site).

4580 **(INIS-mf—8452) Preconditions for and experience with quality assurance in developing countries.** Villate, J. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 39p. (CONF-8009308—54). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703298.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

The main aspects treated in this lecture concern to the differences in passing from conventional projects to nuclear power plants. This step requires the establishment of QA programs covering the activities of the utility, the architect-engineer, the NSSS supplier, the manufacturers and installer in all safety related components and structures. Indicative estimates are given regarding the manpower requirements and the cost of QA in the construction of a nuclear power plant. Special emphasis is granted to the qualifications, training and certification of QA and QC personnel. To illustrate this point and the transfer of technology to developing countries, examples of Mexico and Brazil are presented. Finally, an outline is given of IAEA capability in providing assistance in QA to developing countries.

4581 **(INIS-mf—8453) Review of technical specifications.** Bedrich, M.; Scholz, D. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 21p. (CONF-8009308—55). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703299.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

The present paper deals with position and function of technical specifications before and during the manufacturing of reactor components, their structure and reasons for specific regulations due to safety philosophy and explains the cooperation of supplier, manufacturer, utilities and supervisory organizations.

4582 **Fiscal Year 1984 Department of Energy authorization (nuclear fission R & D and waste management). Hearings before the Subcommittee on Energy Research and Production of the Committee on Science and Technology, US House of Representatives, Ninety-Eighth Congress, First Session, February 22, 23, 24; March 2, 8, 9, 1983. No. 18, Volume IV.** Washington, DC; Government Printing Office (1983). 1044p.

Volume IV of the 1984 DOE budget hearings covers six days of testimony on research and development of nuclear fission and nuclear waste management. Shelby Brewer, defining DOE's mission in terms of work that exceeds the capacity of the private sector, went on to describe the status of work at Clinch River, Three Mile Island, Savannah River, and elsewhere. John Kearney of the Edison Electric Institute emphasized the importance of shifting to coal and nuclear resources in his support of fast-breeder reactor programs. Robert Morgan of the Nuclear Waste Policy Act Project reviewed progress in the effort to construct both permanent radioactive waste repositories and at least one retrievable facility. The remaining 26 witnesses addressed these and other aspects of nuclear fuels production and waste management. Appendices with supplemental questions and responses, statements, and correspondence follow each day's testimony. (DCK)

4583 **Arguments against the utilization of nuclear energy. 2. rev. ed.** Hannover, Germany, F.R.; Institut fuer Oekologische Forschung und Bildung (1982). 80p. (In German). Institut fuer Oekologische Forschung und Bildung, Hannover (Germany, F.R.).

The attempt is made to treat the subject 'nuclear energy' on a large scale. In this brochure, all important problems can only be discussed quite briefly; a great number of footnotes indicating further literature shall guide the reader to thorough study. The text is supposed to serve as a systematic introduction to the problems as well as for looking up individual partial aspects. A lot of space has been given to the presentation of those aspects that concern the risk of nuclear facilities, and the threat to man and environment by their operation. Moreover, fundamental political, scientific-sociological, economic and other social problems are discussed. The objective of this was to give the reader an idea of the social background before which the controversy about the nuclear energy is taking place today and what factors decide its development.

4584 **A multi-dimensional arbitrary Lagrangian-Eulerian method for dynamic fluid-structure interaction.** (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 64**: 298-316(1982). (CONF-820601—).

This paper describes an arbitrary Lagrangian-Eulerian method for analyzing fluid-structure interactions in fast reactor containment with complex internal structures. In the analysis the fluid transient can be calculated either implicitly or explicitly, using a finite-difference mesh with vertices that may be moved with the fluid (Lagrangian), held fixed (Eulerian), or moved in any other prescribed manner (hybrid Lagrangian-Eulerian). The structural response is computed explicitly by two nonlinear, elastic-plastic finite element modules formulated in corotational coordinates. Interaction

between fluid and structure is accounted for by enforcing the interface boundary conditions. The method has convincing advantages in treating complicated phenomena such as flow through perforated structures, large material distortions, flow around corners and irregularities, and highly contorted fluid boundaries. Several sample problems are given to illustrate the effectiveness of this arbitrary Lagrangian-Eulerian method.

4585 **Progress or destruction. Emsland: Information on development and industrialisation of a region.** Schuhl, T.; Deutsch, R.; Klassen, R.; Neie, M.; Roeper, H.; Agena, G.; Kothe, E.; Kroh, E.O.; Ewald, D.; Bensmann, B. Osnabrueck, Germany, F.R.; Buergerinitiative gegen Atomenergie (1980). 146p. (In German). Buergerinitiative gegen Atomenergie, Osnabrueck (Germany, F.R.).

The brochure wants to study the background and consequences of Emsland development and industrialization, then give a view over the planned nuclear plants, infrastructural measures and the development of the industrial sites. Included are also the military objects and facilities in the Emsland that are of special importance. The brochure is supposed to inform a great part of the population and to represent at the same time a materials collection for the work of civic initiative groups.

2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

REFER ALSO TO CITATION(S) 4611, 4619, 4657, 4659, 4662, 4704, 4705, 4707, 4712, 4717, 4719, 4722, 4723, 4726, 4727, 4728, 4731, 4736, 4746, 4748, 4751, 4752, 4758, 4802, 4824

4586 **(INIS-mf—8402) Chemical decontamination for repair and decommissionning of nuclear power plants. FuE-81050. Final report. Period under report: 1 August 1979-31 May 1981.** Demtroeder, P.; Neupert, D. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). 1981. 87p. (In German). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83703307.

The decontamination processes volatilization of metal-oxides and metal-alloys by reaction with aggressive gases and decontamination with strippable decontamination pastes have been tested experimentally. Tests have been made with inactive and radioactive samples, in order to assess the suitability of both decontamination processes. As the material is considerably damaged by decontamination through a gaseous-phase reaction, this process can only be used for special cases. The decontamination pastes developed by Nukem can be applied in all areas of nuclear technology in order to decontaminate radioactive components. Decontamination factors of 10^3 could be obtained after only one application of the pastes, which consist essentially of a decontamination compound, a thickening compound, a film former and other secondary chemicals.

4587 **(INIS-mf—8425) In-service inspection and periodic testing.** Eisele, H.; Meyer, F.A.; Zipser, R.R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 48p. (CONF-8109220—19). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703295.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

In-service inspections are performed to verify the operational safety, and maintenance work is performed to guarantee the availability. Below, the typical in-service inspections of a light-water reactor NPP (operated on a pressurized-water reactor/PWR/ or on a boiling-water reactor/BWR/) are described with details and examples of typical inspections, especially of recurrent performance tests of the systems.

4588 **(INIS-mf—8448) In-service inspection techniques.** Backfisch, W.; Zipser, R.R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 48p. (CONF-8009308—56). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703306.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

The owner of a nuclear power plant (NPP) is obligated and interested to maintain - by regular maintenance and in-service inspections - the operational safety and availability of the plant for the subsequent operating period in a condition, as is specified as the basis of the erection and the last operational permits. In-service inspections are performed to verify the operational safety, and maintenance work is performed to guarantee the availability. Below, the typical in-service inspections of a light-water reactor NPP (operated on a pressurized-water reactor or on a boiling-water reactor) are described with details and examples of typical inspections, especially of recurrent performance tests of the systems.

4589 **Cooling spent fuel pool areas in existing BWR generating stations.** Muray, M.; Gaspercic, R.; Podesfinski, R.A. (Burns & Roe, Inc., 650 Winters Avenue, Paramus, NJ 07675). *Transactions of the American Nuclear Society;* **44**: 469(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

REFER ALSO TO CITATION(S) 4587, 4588, 4613, 4619, 4628, 4657, 4659, 4713, 4714, 4716, 4717, 4718, 4720, 4721, 4723, 4724, 4725, 4726, 4727, 4729, 4730, 4732, 4741, 4742, 4744, 4745, 4746, 4751, 4754, 4757, 4758, 4769, 4771, 4802, 4826

4590 **(ECC/P—3) Plant related variables: plant operations. Evidence to the Sizewell B PWR power station public inquiry.** Thomas, S. (Electricity Consumers' Council, London (UK)). Jun 1983. 41p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE84900255.

The major element in the generation cost of electricity from any nuclear power station is the capital charge arising from the construction cost - for Sizewell the CEGB estimates that capital charges will make up more than 65% of generation cost. Therefore in assessing the cost implications of Sizewell (and subsequent PWRs) it is important to review the capital cost and also the amount of output the plant produces - the more electricity the plant produces, the lower the capital charge per unit of electricity. The capital cost and the factors determining it, such as construction time, are reviewed by Mr. MacKerron (ECC/P/2), while this Proof reviews the parameters which will determine the output of the plant.

4591 **(ECC/P—7) Technology choice and transfer. Evidence to the Sizewell B PWR power station public inquiry.** Thomas, S. (Electricity Consumers' Council, London (UK)). Jun 1983. 42p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE84900023.

While some other ECC Proofs have examined whether Sizewell is likely to meet the performance criteria projected for it, this Proof examines the performance and advantages of the Westinghouse 4-loop PWR over other potential reactor systems, reactor vendors and reactor sizes. Electricity consumers need to be assured that the Westinghouse 4-loop design not only meets the narrow criterion of offering a negative Net Effective Cost (NEC) at Sizewell but also represents either the best or something close to the best buy amongst nuclear reactors. This Proof therefore examines the choice of reactor system, and transfer of the chosen technology to the UK, and relates to the evidence presented in the ECC's Statement of Case in paragraphs 15.1 to 17.4.

4592 **(TVA/OP/EDT—83/27) Degradation of B7 threaded fasteners in borated-water solutions at elevated temperatures.** (Singleton Materials Engineering Labs., Knoxville, TN (USA)). Jul 1983. 15p. NTIS, PC A02/MF A01. Order Number DE84900083.

The enclosed test program was initiated principally because of NRC IE bulletin No. 82-02, which reported severe degradation of Grade B7 fasteners in the reactor coolant pressure boundary due to boric acid attack. Two phases of tests were run at 550°F in boric acid solution. A third phase test is planned, and the results will be issued as a supplement to this publication.

4593 **(PNL-tr—443) DOMPAC dosimetry experiment: neutron simulation of the pressure vessel of a pressurized-water reactor characterization of irradiation damage.** Alberman, A.; Faure, M.; Thierry, M.; Hoclet, O.; Le Dieu de Ville, A.; Nimal, J.C.; Soulat, P. (Pacific Northwest Lab., Richland, WA (USA); CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Nov 1983. Contract AC06-76RL01830. C; CEA-R-5217, May 1983. 110p. NTIS, PC A06/MF A01. Order Number DE84003474.

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The DOMPAC dosimetry experiment is an irradiated PWR pressure vessel simulation and has been performed in the pool of TRITON reactor (Fontenay-aux-Roses). It was designed for radiation damage characterization inside the vessel (neutron spectrum variation). A 20 cm thick ferritic steel block simulated the vessel and was equipped with Services des Piles de Saclay's graphite (G.A.M.I.N.) and tungsten damage monitors. Core/steel block distance was optimized through 1D (ANISN and SABINE) computations. A realistic incident neutron spectrum was obtained by similar damage/activation ratios computed for DOMPAC and FESSENHEIM 1 power plant. Experimental results were found in good agreement with expected fluence gradients inside the vessel.

4594 **Fracture mechanics data deduced from thermal-shock and related experiments with LWR pressure vessel material.** Cheverton, R.D.; Bolt, S.E.; Canonico, D.A.; Holz, P.P.; Iskander, S.K.; Nanstad, R.K.; Stelzman, W.J. (Oak Ridge National Laboratory, Oak Ridge, TN). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 58**: 1-16(1982). (CONF-820601—). Contract W-7405-ENG-26.

Thermal-shock experiments with steel cylinders have been conducted at ORNL to investigate the behavior of long axial inner-surface flaws during loading conditions similar to those imposed by a PWR LOCA. The scope of the three most recent experiments was dictated by results of the PWR-LOCA fracture-mechanics analysis and included initiation and arrest of shallow and deep flaws, a series of initiation-arrest events with deep penetration of the wall, long crack jumps, arrest in a rising K /SUB I/ field, and warm prestressing. For the purpose of designing the experiments and evaluating their results, the static initiation and arrest toughness curves were determined for the test cylinders, and this was done using compact specimens. The experiments demonstrated WPS and arrest in a rising K /SUB I/ field and indicated that LEFM is valid for thermal-shock loading.

2103 Power Reactors, Non-breeding, Graphite Moderated

REFER ALSO TO CITATION(S) 4630, 4631, 4632, 4633, 4634, 4635, 4636, 4637, 4638, 4756

4595 **(GA-A—17185) HTGR Plant Technology Program. Semiannual report for the period ending March 25, 1983.** (GA Technologies, Inc., San Diego, CA (USA)). Aug 1983. Contract AT03-76ET35301. 218p. NTIS, PC A10/MF A01. Order Number DE84001614.

This document reports the technical accomplishments of the HTGR Plant Technology Program at GA Technologies Inc. (formerly General Atomic Company) during the first half of FY-83. It covers a period when the design direction of the National HTGR Program is to support a steam-cycle cogeneration plant with a lesser but continuing emphasis on higher-temperature applications.

2105 Power Reactors, Breeding

REFER ALSO TO CITATION(S) 4708, 4763, 4767, 4768, 4770, 4975

4596 **(CONF-830607—28) Performing dynamic time history analyses by extension of the response spectrum method.** Hulbert, G.M. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1983. Contract AC15-76CL50003. 13p. NTIS, PC A02/MF A01. Order Number DE84001852.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

A method is presented to calculate the dynamic time history response of finite-element models using results from response spectrum analyses. The proposed modified time history method does not represent a new mathamatical approach to dynamic analysis but suggests a more efficient ordering of the analytical equations and procedures. The modified time history method is considerably faster and less expensive to use than normal time hisory methods. This paper presents the theory and implementation of the modified time history approach along with comparisons of the modified and normal time history methods for a prototypic seismic piping design problem.

4597 **(CONF-830702—29) Comparison of results between the DEMO 1-D and the COMMIX 3-D analysis of the CRBRP-IHX under a natural-circulation event.** Cheung, A.C.; Kao, T.T.; Cho, S.M.; Lowrie, R.R. (Westinghouse Electric Corp., Pittsburgh, PA (USA); Foster Wheeler Energy Applications, Inc., Livingston, NJ (USA)). 1983. Contract AC15-76CL50003. 8p. NTIS MF A01. Order Number DE84001849.

From 21. ASME/AIChE national heat transfer conference; Seattle, WA, USA (24 Jul 1983).

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In order to assess the multi-dimensional thermal-hydraulic effects in an intermediate heat thermal-hydraulic effects in an intermediate heat exchanger (IHX) and to ascertain the adequacy of the DEMO one-dimensional (1-D) IHX model in natural circulation analysis, a comparison of the predictions by the DEMO and the COMMIX three-dimensional (3-D) computer code has been conducted. The CRBRP IHX configuration was used in this benchmark comparison. The COMMIX results clearly demonstrated that there is no significant flow channeling or stratification on either the shell or tube side of the CRBRP IHX during the postulated natural circulation event. Comparisons of the integrated thermal heads predicted by the two codes for the CRBRP IHX show differences of .013 and .024 psi (90 and 164 W/m^2 for both the primary and the secondary side respectively. These results demonstrate that, while a 1-D IHX model can not predict the velocity and temperature distribution inside the IHX in complete detail, it is adequate for the analysis of a heat transport system under design base natural circulation events (i.e. accidents initiated by the simultaneous loss of all AC power during power operation).

4598 **(CONF-8310198—2) Overview of US LMFBR Structural Materials Mechanical Properties Program.** Horak, J.A.; Purdy, C.M. (Oak Ridge National Lab., TN (USA); USDOE Assistant Secretary for Nuclear Energy, Washington, DC. Office of Breeder Technology Projects). 1983. Contract W-7405-ENG-26. 37p. NTIS, PC A03/MF A01. Order Number DE84001960.

From IAEA specialists on mechanical properties of structural materials; Chester, UK (10 Oct 1983).

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This paper presents the objective, scope, and status of the US Department of Energy's Materials and Structures Program to develop a data base on mechanical properties of structural materials for out-of-core structures and components for LMFBRs. Information on the development of a reference data base on materials for the reactor system, reactor enclosure system, primary heat transport system, intermediate heat transport system, and steam generator system is included. In addition, the development of the data and analyses to account for the effects of temperature and stress, as well as water/steam, sodium, and radiation environments, is described. Plans for the development of alternative materials for future out-of-core applications are presented.

4599 **(KAPL—4155) Conceptual design of a 1000-MWe light-water-moderated prebreeder/breeder reactor system based on the seed-blanket principle (AWBA Development Program).** Merriman, F.C.; Detwyler, J.M. (Knolls Atomic Power Lab., Schenectady, NY (USA)). May 1983. Contract AC12-76SN00052. 315p. NTIS, PC A14/MF A01. Order Number DE84001889.

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A practical light water moderated breeder reactor design concept is described which is based on the technology of PWRs and which uses the Th/U-233 fuel cycle. On the equilibrium core cycle, the breeder is self-sustaining, producing enough new fissile fuel to load the next core cycle with allowance for up to 1% fissile losses during fuel reprocessing and refabrication. The reactor system proceeds through two phases of operation in the same reactor plant: a prebreeder phase and a breeder phase. During the early prebreeder phase the core is fueled with naturally available U-235 and Th to produce the U-233 needed to start the breeder phase. During the breeder phase the reactor continues operation with U-233 being recycled through succeeding core cycles. The principal geometric difference between the prebreeder and breeder cores is a smaller fuel element diameter in the prebreeder core. Cumulative uranium mill ore requirements to attain the equilibrium breeder core cycle are calculated to range from 2700 to 3900 short tons U_3O_8 per gigawatt electric capacity (including ex-core fuel inventory) for assumed fissile losses during fuel recycle ranging from 0.5% to 1.0%, and for an assumed time period ranging from one to two years for recycling discharged fuel. Good neutron economy in a practical size core is obtained by arranging the core into a pattern of seed regions containing ThO_2-UO_2 fuel and blanket regions containing only ThO_2 fuel. The seed-blanket core arrangement levels core lifetime reactivity variation at full power with minimal use of neutron poisons for reactivity control. The nuclear, mechanical and thermal/hydraulic design features of the prebreeder/breeder concept are described. Performance predictions show that both the prebreeder and breeder reactors are expected to have performance and safety margins comparable to a commercial PWR.

4600 **(LA—9844-PR) Examination of fast reactor fuels and FBR analytical quality-assurance standards and methods. Progress report, April 1-June 30, 1983.** Maraman, W.J. (comp.). (Los Alamos National Lab., NM (USA)). Sep 1983. Contract W-7405-ENG-36. 6p. NTIS, PC A02/MF A01. Order Number DE84002313.

This is the 35th quarterly report of the Examination of Fast Reactor Fuels and Fast Breeder Reactor (FBR) Analytical Quality-Assurance Standards and Methods at the Los Alamos National Laboratory. Most of the investigations discussed here are of the continuing type. Results and conclusions described may therefore be changed or augmented as the work progresses. Published reference to results cited in this report should not be made without obtaining explicit permission to do so from the person in charge of the work.

4601 **Nonlinear fluid/structure interaction relating a rupture-disc pressure-relief device.** Hsieh, B.J.; Kot, C.A.; Shin, Y.W.; Youngdahl, C.K. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 75**: 175-184(1983). (CONF-830607—).

Rupture disc assemblies are used in piping network systems as pressure-relief devices. The reverse-buckling type discs are chosen for application in heat transport systems of liquid metal fast breeder reactors. When the pressure on the disc is of sufficient magnitude and duration, the disc develops large displacement, is consequently torn open by a cutting-knife setup and thus relieves the excess pressure. Such disc assemblies are used very successfully in systems in which the fluid is highly compressible, e.g., air; the opening of the disc by the knife setup is complete. However, this is not true for a liquid system; in this case it has been observed experimentally that the disc may open up only partially or not at all. Therefore, to understand and realistically represent a rupture disc assembly in a liquid environment, the fluid-structure interactions between the liquid medium and the disc assembly must be considered. In this paper, methods for analyzing the fluid and the disc and the mechanism interconnecting them are presented. When necessary the fluid is allowed to cavitate through a column separation model and the disc can become plastically deformed using the classic Von Mises' yield criteria.

4602 **FFTF thermal-hydraulic testing results affecting piping and vessel component design in LMFBR's.** Stover, R.L.; Beaver, T.R.; Chang, S.C. (Engineering Analysis, Engineering Department, Westinghouse Hanford Company, Richland, Washington 99352). *American Society of Mechanical Engineers, [Paper];* No. 83-NE-5, 7(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

The Fast Flux Test Facility completed four years of preoperational testing in April 1982. This paper describes thermal-hydraulic testing results from this period which impact piping and vessel component design in LMFBRs. Data discussed are piping flow oscillations, piping thermal stratification and vessel upper plenum stratification. Results from testing verified that plant design limits were met.

4603 **Fatigue of LMFBR piping due to flow stratification.** Woodward, W.S. (Westinghouse Electric Corp., Madison, PA). *American Society of Mechanical Engineers, [Paper];* No. 83-PVP-59, 9(1983). (CONF-830607—). Contract AC15-76CL50003.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

Flow stratification due to reverse flow was simulated in a 1/5 scale water model of a LMFBR primary pipe loop. The stratified flow was observed to have a dynamic interface region which oscillated in a wave pattern. The behavior of the interface was characterized in terms of location, local temperature fluctuation and duration for various reverse flow conditions. A structural assessment was performed to determine the effects of stratified flow on the fatigue life of the pipe. Both the static and dynamic aspects of flow stratification were examined. The dynamic interface produces thermal striping on the inside of the pipe wall which is shown to have the most deleterious effect on the pipe wall and produce significant fatigue damage relative to a static interface.

4604 **A conceptual design of a large LMFBR intermediate heat exchanger.** Cho, S.M.; Chou, H.L.; Dawson, B.E. (Foster Wheeler Energy Applications, Inc.). *American Society of Mechanical Engineers, [Paper];* No. 82-NE-4, 9(1982). (CONF-820705—).

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

Advanced conceptual design is continuing for a 1000 MWe Liquid Metal Fast Breeder Reactor (LMFBR) Large Development Plant (LDP) that would follow the Clinch River Breeder Reactor Demonstration Plant (CRBRP). The LD employs a loop-type primary heat transport system with hot-leg primary pumps. In support of this work, the conceptual design of large-size intermediate heat exchangers (IHX) has been undertaken. The overall unit configuration is similar to the CRBRP-IHX's in that a counterflow arrangement with a central downcomer is employed. This paper presents the thermal and hydraulic design aspects of the LDP-IHX. Two different thermal ratings of 643.5 and 965.25 MWt are considered and an option to add a primary reactor auxiliary cooling system (PRACS) in the inlet plenum of the 643.5 MWt IHX is also investigated. Further research and development programs are identified.

4605 **Load-deflection characteristics of small bore insulated pipe clamps.** Severud, L.K.; Clark, G.L. (Westinghouse Hanford Company, Richland, Washington). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP.-VOL. 68**: 95-107(1982). (CONF-820601—). Contract AC06-76FF02170.

High temperature LMFBR piping is subject to rapid temperature changes during transient events. Typically, this pipe is supported by specially designed insulated pipe clamps to prevent excessive thermal stress from developing during these transients. The special insulated clamps used on both FFTF and CRBR piping utilize a Belleville spring arrangement to compensate for pipe thermal expansion. Analysis indicates that this produces a non-linear, directionally sensitive clamp spring rate. Since these spring rates influence the seismic response of a supported piping system, it was deemed necessary to evaluate them further by test. This has been accomplished for the FFTF clamps. A more standard insulated

pipe clamp, which does not incorporate Belleville springs to accommodate thermal expansion, was also tested. This type clamp is simple in design, and economically attractive. It may have wide application prospects for use in LMFBR small bore auxiliary piping operating at temperatures below 427°C. Load deflection tests were conducted on 2.54 CM and 7.62 CM diameter samples of these commercial clamps.

4606 **Scoping calculations for design and analysis of large reactor vessels for liquid-metal fast breeder reactor (LMFBR) plants.** Seidensticker, R.W.; Fiala, C.; Kulak, R.F.; Ma, D.C.; Pan, Y.C.; Yang, C.Y.; Zeuch, W.R. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division,* [*Technical Report*] *PVP;* **PVP-VOL.57**: 141-154(1982). (CONF-820601—).

Reactor vessels for commercial-sized LMFBR plants are quite large -- ranging 12-22 m (40-70 ft) in diameter and 15-22 m (50-70 ft) in overall depth. These stainless steel vessels contain liquid sodium at relatively low pressures, but at high temperatures. The resulting thin-walled vessels present the structural designer and analyst with special problems, particularly in providing a balanced design to accommodate seismic loads, design basis accident loads, and thermal loadings. A comprehensive set of scoping calculations made for a conceptual design -- though preliminary in detail and depth of design -- provides substantial guidance to the vessel designer for subsequent design iterations. Emphasis is placed on the analysis of the large diameter top closure of the vessel -- the deck structure.

4607 **Three-dimensional numerical modeling of heat exchangers.** Sha, W.T.; Cho, S.M.; Kao, T.T.; Yang, C.I. (Argonne National Laboratory, Argonne, Illinois). *American Society of Mechanical Engineers,* [*Paper*]; No. 82-NE-1, 9(1982). (CONF-820705—).

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

A comprehensive, multi-dimensional, thermal-hydraulic model is developed for the analysis of shell and tube heat exchangers for liquid metal services. For the shell-side fluid, the conservation equations of mass, momentum and energy for continuum fluids are modified using the concept of porosity, surface permeability and distributed resistance to account for the blockage effects due to the presence of heat transfer tubes, flow baffles/shrouds, tube support plates, etc. On the tube side, the heat transfer tubes are connected in parallel between the inlet and outlet plenums, and tube-side flow distribution is calculated based on the plenum-to-plenum pressure difference being equal for all tubes. It is assumed that the fluid remains single-phased on the shell side and may undergo phase-change on the tube side, thereby simulating the conditions of Liquid Metal Fast Breeder Reactor (LMFBR) intermediate heat exchangers (IHX) and steam generators (SG). The analytical model predictions are compared with three sets of test data (one for IHX and two for SG, and favorable results are obtained, thus providing a limited validation of the model.

4608 **Predictions of natural circulation tests in FFTF.** Cheung, A.; Coffield, R.D.; Daschke, K.D.; Markley, R.A.; Planchon, H.P.; Severson, W.J.; Tang, Y.S. (Westinghouse Advanced Reactors Division, Madison, PA). *American Society of Mechanical Engineers,* [*Paper*]; No. 82-NE-25, 9(1982). (CONF-820705—). Contract AC15-76CL02395.

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

Natural circulation cooling of the LMFBR core exhibits one of the few core design transients where low power/high temperature conditions exist. Core inter-assembly and intra-assembly flow/heat redistribution become significant under such conditions, which has the effect of reducing the maximum hot-rod temperature. A system of three computer codes was used in sequence to analyze core cooling capability during natural circulation, and this methodology is demonstrated by the prediction of FFTF natural circulation tests. Published, measured data are compared with the pre- and post-test predictions. A good agreement between the predictions and these data is shown which lends confidence to the methodology used.

4609 **Thermal-Hydraulic-Structural behavior of the EBR-II IHX for overpower transients.** Mohr, D.; Chang, K.; Feldman, E.E.; Lee, M.J. (Argonne National Laboratory, Argonne, Illinois). *American Society of Mechanical Engineers,* [*Paper*]; No. 82-NE-35, 7(1982). (CONF-820705—).

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

A detailed study has been made of the effects of the Operational Reliability Testing (ORT) program on major plant components of the Experimental Breeder Reactor No. II (EBR-II). This paper describes the integrated thermal-hydraulic-structural analyses conducted for the intermediate heat exchanger (IHX) with the aid of the NATDEMO, THTB, and ANSYS codes. An extensive analysis revealed the stress limiting area to be the junction between the upper head and upper tube sheet. The analyses indicate, however, that the EBR-II IHX, the major plant component most affected by the ORT program, will be able to withstand the thermal stress and accumulated fatigue damage during the lifetime of the plant including the ORT program.

2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

4610 **(DOE/SNP—1-Rev.O) Nuclear-safety criteria and specifications for space nuclear reactors.** (USDOE Assistant Secretary for Nuclear Energy, Washington, DC. Office of Space Nuclear Projects). Aug 1982. 18p. NTIS, PC A02/MF A01. Order Number DE84002329.

The policy of the United States for all US nuclear power sources in space is to ensure that the probability of release of radioactive material and the amounts released are such that an undue risk is not presented, considering the benefits of the mission. The objective of this document is to provide safety criteria which a mission/reactor designer can use to help ensure that the design is acceptable from a radiological safety standpoint. These criteria encompass mission design, reactor design, and radiological impact limitation requirements for safety, and the documentation required. They do not address terrestrial operations, occupational safety or system reliability except where the systems are important for radiological safety. Specific safety specifications based on these criteria shall also be generated and made part of contractual requirements.

2107 Regulation And Licensing

REFER ALSO TO CITATION(S) 4733, 4808, 4809, 4810, 4811, 4812, 4813, 4814, 4815, 4829

4611 **(ANSI/ANS—6.6.1-1979) American National Standard: for calculation and measurement of direct and scattered gamma radiation from LWR nuclear power plants.** (American Nuclear Society, La Grange Park, IL). Jan 1979. 48p. American Nuclear Society, 555 North Kensington Ave., LaGrange Park, IL 60525 $32.00.

This standard defines calculational requirements and discusses measurement techniques for estimates of dose rates near liquid water reactor (LWR) nuclear power plants due to direct and scattered gamma-rays from contained sources on-site. On-site locations outside plant buildings and locations in the offsite unrestricted area are considered. All sources that contribute significantly to dose rates are identified and methods for calculating the source strength of each are discussed. Particular emphasis is placed on ^{16}N sources as they are significant sources of direct and scattered radiation for boiling water reactors (BWR). The standard specifically excludes radiation from gaseous and liquid effluents. The standard describes the considerations necessary to compute dose rates, including component self-shielding, shielding afforded by walls and structures, and scattered radiation. The requirements for measurements and data interpretation of measurements are given. The standard includes normal operation and shutdown conditions but does not address accident or normal operational transient conditions.

4612 **(ANSI/ANS—18.5-1982) American National Standard: for surveys of terrestrial ecology needed to license thermal power plants.** (American Nuclear Society, La Grange Park, IL). Sep 1982. 32p. American Nuclear Society, 555 North Kensington Ave., Lagrange, Park, IL 60525 $30.00.

This standard discusses the need developers of thermal power plants and their associated facilities have for information on the terrestrial environment. Utilities and regulatory agencies must collect information to predict and assess real and potential environmental impacts, and to site and design generating plants that avoid or reduce adverse effects. Users of this standard will be guided through each stage of a survey with its corresponding requirements, the relationship of the terrestrial ecologist and other specialists in a major project, sources of information, and the governing laws and regulations.

4613 **(ECC/P—5) Sizewell B power station public inquiry. Proof of evidence on: deferment.** Jones, I.S. (Electricity Consumers' Council, London (UK)). Jun 1983. 32p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE84900025.

In order to show that commissioning Sizewell B at the earliest possible date is good value for money, the CEGB must first demonstrate that the expected Net Effective Cost (NEC) of the project is less than the Net Avoidable Cost (NAC) of operating existing marginal plant. In Part II of the Proof, the CEGB's analysis of the expected costs and benefits of deferment is examined. Part III examines the possible timespan for deferment, given the expected growth in demand for electricity in Scenario C and the development of the CEGB's generating capacity. Part IV consists of a summary and conclusions. The Proof as a whole supports the arguments advanced in paragraphs 9.1 to 9.5 of the ECC Statement of Case (ECC/01).

4614 **(NUREG—0750-Vol.17-No.3) Nuclear Regulatory Commission issuances. Volume 17, No. 3.** (Nuclear Regulatory Commission, Washington, DC (USA). Div. of Technical Information and Document Control). Mar 1983. 203p. NTIS, PC A10/MF A01 - GPO. Order Number DE84900269.

This report contains the Issuances received during March 1983 from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors Decisions (DD), and the Denials of Petition for Rulemaking (DPRM). The Issuances concerned the following facilities: Three Mile Island Nuclear Station, Unit No. 1; Comanche Peak Steam Electric Station, Units 1 and 2; Vallecitos Nuclear Center; Floating Nuclear Power Plants; San Onofre Nuclear Generating Station, Units 2 and 3; Point Beach Nuclear Plant, Unit 1; Perry Nuclear Power Plant, Units 1 and 2; Shoreham Nuclear Power Station, Unit 1; Western New York Nuclear Service Center; Limerick Generating Station, Units 1 and 2; Seabrook Station, Units 1 and 2; Black Fox Station, Units 1 and 2; WmH Zimmer Nuclear Power Station, Unit 1; WPPSS Nuclear Project No. 1; Zion Nuclear Plant, Units 1 and 2; and South Texas Project, Units 1 and 2. (DMC)

4615 **American National Standard: medical certification and monitoring of personnel requiring operator licenses for nuclear power plants.** La Grange Park, IL; American Nuclear Society (1983). 12p. (ANSI/ANS—3.4-1983). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $10.00.

This standard defines the physical and mental requirements for licensure as a nuclear reactor operator. It also addresses the content, extent, and methods of examination.

4616 **Nuclear emergency planning. Hearing before the Subcommittee on Nuclear Regulation of the Committee on Environment and Public Works, United States Senate, Ninety-Eighth Congress, First Session, April 15, 1983.** Washington, DC; Government Printing Office (1983). 420p.

With emergency plans now approved for 16 nuclear power plant sites and preliminary plans at varying stages of development for the remaining 37 sites (in accordance with section 109 of the 1980 Nuclear Regulatory Commission [NRC] authorization), concerns continue over the status of emergency planning at plants under construction. Of particular concern to the committee was evidence that state and local governments are misusing section 109 in order to gain concessions from the utilities. NRC Chairman Palladino described the agency's review process before it awards an operating license. George Gleason of the American Nuclear Energy Council found fault with the system, which gives utilities responsibility without the authority for an emergency plan, while a spokesman for the Union of Concerned Scientists called for an open review process and questioned whether utilities can assume the functions of government in an emergency situation. Additional statement and letters submitted for the record follow the testimony of the seven witnesses. (DCK)

4617 **American National Standard: for selection, qualification, and training of personnel for nuclear power plants.** La Grange Park, IL; American Nuclear Society (1981). 27p. (ANSI/ANS—3.1-1981). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $25.00.

This standard provides criteria for the selection, qualification, and training of personnel for stationary nuclear power plants. Qualifications, responsibilities, and training of personnel in operating and support organizations appropriate for the safe and efficient operation of nuclear power plants are addressed. Individual job titles and organizational structures vary among organizations operating power reactors; therefore, this standard is predicated on levels of responsibility rather than on a particular organizational concept.

4618 **American National Standard: for evaluation of radionuclide transport in ground water for nuclear power sites.** La Grange Park, IL; American Nuclear Society (1980). 29p. (ANSI/ANS—2.17-1980). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $28.00.

This standard presents guidelines for the determination of the concentration of radionuclides in the ground water resulting from both postulated accidental and routine releases from nuclear power plants. This standard presents the methods to evaluate potential radionuclide transport in ground water for use in evaluation of nuclear power plant sites. This standard contains mandatory requirements as designated by the use of the word shall.

4619 **American National Standard: for solid radioactive-waste-porprocessing system for light-water-cooled-reactor plants.** La Grange Park, IL; American Nuclear Society (1979). 34p. (ANSI/ANS—55.1-1979). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $28.00.

This standard sets forth design, construction, and performance requirements with due consideration for operation of the Solid Radioactive Waste Processing System for light water-cooled reactor plants for design basis inputs. For the purpose of this standard, the Solid Radioactive Waste Processing System begins at the interface with the liquid radioactive waste processing system boundary, at the inlets to the spent resin, filter sludge, evaporator concentrate, and phase separator tanks. All radioactive or contaminated materials, including spent air and liquid filter elements, spent bead resins, filter sludge, spent powdered resins, evaporator and reverse osmosis concentrates, and dry radioactive wastes shall be processed in appropriate portions of the solid radioactive waste system. The system terminates at the point of loading the filled drums and other containers on a vehicle for shipping off-site to a licensed burial site. The Solid Radioactive Waste Processing System is not a safety class system as defined by American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, N18.2-1973/ANS-51.1 and it's revision, N18.2a-1975/ANS-51.8, Sections 2.2 and 2.3., and the similar draft standards for boiling water reactor plants. The provisions contained in this standard, therefore, shall take precedence over the aforementioned standards. The product resulting from the solid radioactive waste processing system will meet the criteria imposed by standards and regulations for transportation and burial.

4620 **American National Standard: generic requirements for light-water nuclear power plant fire protection.** La Grange Park, IL; American Nuclear Society (1979). 51p. (ANSI/ANS—59.4-1979). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $35.00.

This standard establishes criteria for fire prevention and protection of the nuclear-safety-related structures, systems, and components of light water reactor nuclear power plants. The purpose of this standard is to establish the basis for a fire prevention and protection program in light water reactor nuclear power plants using the defense-in-depth concept. The criteria given are statements of minimum acceptable performance. This document specifies detailed requirements where related standards do not provide the necessary details. Where details are available in other standards, these are referenced and when used in conjunction with this standard will provide a complete statement and categorization of the minimum requirements for fire prevention and protection.

4621 **American National Standard: for radiological emergency-preparedness exercises for nuclear power plants.** La Grange Park, IL; American Nuclear Society (1979). 8p. (ANSI/ANS—3.7.3-1979). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $10.00.

The development of emergency plans and procedures should provide for testing and evaluating the emergency response organization and decision making processes. To test and evaluate emergency plans and procedures, realistic scenarios should be used for drills or exercises. Emergency exercises are training activities that require a substantial effort to plan and coordinate effectively. The exercise trains personnel who would be expected to participate in the emergency response. Emergency exercises should be conducted as realistically as possible. Insofar as possible, the participants should not be notified in advance except where necessary to assure that the exercise will not cause injuries or property damage. A real emergency will naturally impart stress on emergency response personnel and their organizations. Exercises should be designed to duplicate this sense of stress insofar as practical. An important element of testing the emergency response is to ensure that provisions have been made for observation, evaluation, and critiquing each exercise. These evaluations and critiques should be used to improve and revise emergency plans and procedures where required.

4622 **American National Standard: guidelines for combining natural and external man-made hazards at power-reactor sites.** La Grange Park, IL; American Nuclear Society (1978). 57p. (ANSI/ANS—2.12-1978). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $35.00.

This standard presents guidelines which will allow power reactor designers to select: (1) combinations of natural hazards; (2) combinations of external man-made hazards; and (3) combinations of natural and external man-made hazards to be used in the design of power reactor structures, systems, and components. The hazards to be considered in these categories are identified. Probability level acceptance criteria are defined which will enable designers to select the combinations of hazards which are design bases for a particular site. Methods for calculating probabilities of combinations are discussed.

4623 **American National Standard: guidelines for evaluating site-related geotechnical parameters at nuclear power sites.** La Grange Park, IL; American Nuclear Society (1978). 37p. (ANSI/ANS—2.11-1978). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $30.00.

This standard presents guidelines for evaluating site-related geotechnical parameters for nuclear power sites. Aspects considered include geology, ground water, foundation engineering, and earthwork engineering. These guidelines identify the basic geotechnical parameters to be considered in site evaluation, and in the design, construction, and performance of foundations and earthwork aspects for nuclear power plants. Also included are tabulations of typical field and laboratory investigative methods useful in identifying geotechnical parameters. Those areas where interrelationships with other standards may exist are indicated.

4624 **American National Standard: research-reactor site evaluation.** La Grange Park, IL; American Nuclear Society (1978). 16p. (ANSI/ANS—15.7-1977). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $12.00.

This standard is to be used in evaluating research reactor sites and their associated boundaries.

4625 **American National Standard: selection and training of personnel for research reactors.** La Grange Park, IL; American Nuclear Society (1978). 11p. (ANSI/ANS—15.4-1977). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $10.00.

This standard provides criteria for the selection and training of operating personnel for research reactors. It addresses itself to the qualifications, certification responsibilities, training, requalification, and recertification of operating personnel. This standard is predicated on levels of responsibility rather than on a particular organizational concept.

4626 **American National Standard: radiological control at research-reactor facilities.** La Grange Park, IL; American Nuclear Society (1977). 18p. (ANSI/ANS—15.11-1977). American Nuclear Society, 555 North Kensington Avenue, La Grange Park, IL 60525 $12.00.

This Standard describes the minimum elements of a radiological control plan necessary to provide an acceptable level of radiation protection for personnel at research reactor facilities and the general publis. The purpose is to provide guidance for establishing radiological control in research reactor facilities in a manner that will maintain population exposures as low as is reasonably achievable.

2108 Economics

REFER ALSO TO CITATION(S) 4806, 4816, 4817, 4818, 4819, 4820, 4821, 4822, 4823, 4824, 4825, 4826, 4827, 4828, 4831, 4832, 4833

4627 **(DOE/NE—0030/8) US central station nuclear electric generating units: significant milestones. Status as of January 1, 1983.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Aug 1983. 37p. NTIS, PC A03/MF A01. Order Number DE84000816.

This report contains a map showing the location of nuclear power plants in the USA. In addition, data on the status of US central station nuclear power stations are tabulated. Data elements include net capacity and number of units in operation. (DMC)

4628 **(ECC—1) Electricity consumers' council statement of case to the Sizewell B power station public inquiry.** (Electricity Consumers' Council, London (UK)). Feb 1983. 52p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE84900195.

The Electricity Consumers' Council (ECC) was set up by Government in November 1977 to represent the interests of electricity consumers in England and Wales at national level. The appraisal of Sizewell is carried out using various techniques to derive the net effective cost (NEC). The NEC is expressed as the total system cost per installed kW of capacity of new plant. The impact of Sizewell (and other potential projects) is evaluated against alternative plant-mix backgrounds, i.e., the characteristics, particularly fuel type, of the other power stations on the system. This evaluation of the system impact of Sizewell is carried out using three different investment policies that the CEGB might follow: a moratorium of further nuclear construction; a medium nuclear background; and a high nuclear background. The results are then expressed in terms of the impact of Sizewell on the overall cost of the CEGB system (net effective cost), and shown for four scenarios and all plant-mix backgrounds.

4629 **(ECC/P—4) Sizewell B power station public inquiry: proof of evidence.** Jones, I.S. (Electricity Consumers' Council, London (UK)). Jun 1983. 59p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE84900204.

This Proof examines the CEGB's analysis and forecasting of fossil fuel prices. It is organized as follows. Part II considers the CEGB's analysis and forecasts of world market prices for coal and crude oil. Part III discusses the Board's analysis and forecasts of the real sterling exchange rate, which converts world market prices into sterling prices. Part IV discusses the CEGB's coal price model which forecasts the marginal system cost of coal given a world price expressed in sterling terms. Part V contains a summary and conclusions, including an assessment of the implications of the earlier discussion for the estimated NEC of Sizewell. Attention is focussed on the Board's Scenario C as a central or reference case and on prospects up to the year 2000.

2109 Process Heat Reactors

4630 **(DOE/ET/34202—87) Advanced Gas-Cooled Nuclear Reactor Materials Evaluation and Development Program. Progress report, April 1, 1983-June 30, 1983.** Kimball, O.F. (General Electric Co., Schenectady, NY (USA). Advanced Reactor Systems Dept.). 15 Aug 1983. Contract AC02-76ET34202. 85p. NTIS, PC A05/MF A01. Order Number DE84000041.

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Objectives are to evaluate candidate alloys for very high temperature reactor (VHTR) applications, particularly nuclear process heat (NPH) applications, in terms of the effects of simulated reactor primary coolant (helium containing small amounts of various other gases), high temperatures, and long time exposure on the mechanical properties and structural and surface stability. A second objective is to select and recommend materials for future test facilities and more extensive qualification programs and to develop the critical high temperature materials data needed for the design of major system components, especially those in the primary coolant circuit. Work covered in this report includes the activities associated with modifications and operation of the simulated reactor helium supply system and testing equipment. Progress on the multispecimen creep testing extensions to 15,000 hours is discussed. The status of creep rupture testing in simulated HTGR helium and in air is covered. The status of fatigue testing in simulated HTGR helium is described; the test results obtained are listed and discussed. Status of materials and testing work is presented.

4631 **(DOE/SF/02034—T83) Review of the cost estimate and schedule for the 2240-MWt high-temperature gas-cooled reactor steam-cycle/cogeneration lead plant.** (Bechtel Group, Inc., San Francisco, CA (USA)). Sep 1983. Contract AC03-78SF02034. 66p. NTIS MF A01. Order Number DE84000877.

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This report documents Bechtel's review of the cost estimate and schedule for the 2240 MWt High Temperature Gas-Cooled Reactor Steam Cycle/Cogeneration (HTGR-SC/C) Lead Plant. The overall objective of the review is to verify that the 1982 update of the cost estimate and schedule for the Lead Plant are reasonable and consistent with current power plant experience.

4632 **(DOE/SF/70046—T1) High-temperature gas-cooled reactor steam-cycle/cogeneration lead plant reactor system design description.** (GA Technologies, Inc., San Diego, CA (USA)). [nd]. Contract AT03-76SF70046. 88p. NTIS, PC A05/MF A01. Order Number DE84002160.

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The primary functions of the Reactor System are to generate heat from fission energy, to transfer that heat to the primary coolant, and to control the coolant flow distribution and neutron generation rate in the core. The Reactor System also provides shielding for the Reactor Vessel. The most important safety function is to constitute the first barrier to fission product release. This function is performed jointly by the coated fuel particles and the graphite of the fuel elements. The system also assures adequate control of the neutron generation rate under all postulated plant conditions. The Reactor System consists of the graphite moderated reactor core and its associated supports, controls, and instrumentation and is primarily located inside the pressure boundary of the Reactor Vessel, either in the core cavity or in the adjoining top head penetrations. The installation of the inital core is included in the scope of the system.

4633 **(DOE/SF/70046—T2) High-temperature gas-cooled reactor steam-cycle/cogeneration lead plant. Plant Protection and Instrumentation System design description.** (GA Technologies, Inc., San Diego, CA (USA)). 1983. Contract AT03-76SF70046. 142p. (HCD—33200). NTIS, PC A07/MF A01. Order Number DE84002156.

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The Plant Protection and Instrumentation System provides plant safety system sense and command features, actuation of plant safety system execute features, preventive features which maintain safety system integrity, and safety-related instrumentation which monitors the plant and its safety systems. The primary function of the Plant Protection and Instrumentation system is to sense plant process variables to detect abnormal plant conditions and to provide input to actuation devices directly controlling equipment required to mitigate the consequences of design basis events to protect the public health and safety. The secondary functions of the Plant Protection and Instrumentation System are to provide plant preventive features, sybsystems that monitor plant safety systems status, subsystems that monitor the plant under normal operating and accident conditions, safety-related controls which allow control of reactor shutdown and cooling from a remote shutdown area.

4634 **(DOE/SF/70046—T3) High-Temperature Gas-cooled Reactor steam-cycle/cogeneration lead plant fuel handling, storage, and shipping: system design description.** (GA Technologies, Inc., San Diego, CA (USA)). [nd]. Contract AT03-76SF70046. 183p. (HCD—33400). NTIS, PC A09/MF A01. Order Number DE84002161.

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The fuel handling, storage, and shipping system is comprised of those subsystems, components, and structures that facilitate the following activities: fuel removal and replacement in the reactor core; new (fresh or recycle) fuel receipt, handling, and storage; and irradiated fuel handling (out of core), storage, packing, and shipping. Fuel removal and placement in the reactor core is accomplished with the reactor shutdown and the primary coolant at approximately atmospheric pressure. The system is capable of accomplishing the in core fuel handling activities in a reliable manner commensurate with the plant availability requirements. Specifications are presented.

4635 **(DOE/SF/70046—T4) High-temperature gas-cooled reactor steam-cycle/cogeneration lead plant heat transport system design description.** (GA Technologies, Inc., San Diego, CA (USA)). 1983. Contract AT03-76SF70046. 139p. (HCD—32100). NTIS, PC A07/MF A01. Order Number DE84002808.

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The Heat Transport System consists of the pressurized helium primary coolant volume enclosed within the prestressed concrete reactor vessel liner and of the components associated with the transfer of heat emerging from the core to the feedwater in the steam generators. Specifically, the Heat Transport System helium is that contained within the four main and the three auxiliary loops (including the ducts), the plenum above the core, the core itself and the plenum below the core. This helium interfaces with the prestressed concrete reactor vessel liner and its closures, the core, the thermal barriers and the portions of the Heat Transport and Auxiliary Heat Removal Systems components which form the primary coolant pressure retaining boundaries. Specifications are presented.

4636 **(DOE/SF/70046—T5) High-Temperature Gas-cooled Reactor steam-cycle/cogeneration lead plant auxiliary heat removal: system design description.** (GA Technologies, Inc., San Diego, CA (USA)). 1981. Contract AT03-76SF70046. 132p. (HCD—32800). NTIS, PC A07/MF A01. Order Number DE84002163.

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The Auxiliary Heat Removal System (AHRS) is an engineered safety system included in the 2240 MW(t) HTGR-SC/C Plant to remove heat from the reactor core and primary coolant

whenever heat removal through the main primary coolant loops and steam system is not available and the reactor has been tripped. As its name implies, this system functions as a backup system for the removal of heat from the reactor and thereby maintain plant protection and control of radionuclide release from the core. As designed AHRS consists of three functionally identical heat transport loops. The scope of the system includes the Auxiliary Circulator Subsystem (ACS) and the Auxiliary Heat Exchanger (AHE), both of which interface with the primary, coolant, the Auxiliary Heat Removal Control Subsystem, controlling power to the Auxiliary Circulator, and Auxiliary Cooling Water Subsystem comprising the secondary circuit that transports the heat removed from the AHE to the system ultimate heat sink for the AHRS, which is ambient air, and the Auxiliary Circulator Motor Cooling Subsystem.

4637 **(DOE/SF/70046—T6) High-Temperature Gas-cooled Reactor steam-cycle/cogeneration lead plant reactor vessel: system design description.** (GA Technologies, Inc., San Diego, CA (USA)). 1983. Contract AT03-76SF70046. 64p. (HCD—31100). NTIS, PC A04/MF A01. Order Number DE84002646.

The Reactor Vessel System contains the primary coolant inventory within a gas-tight pressure boundary, and provides the necessary flow paths and overpressure protection for this pressure boundary. The Reactor Vessel System also houses the components of the Reactor System, the Heat Transport System, and the Auxiliary Heat Removal System. The scope of the Reactor Vessel System includes the prestressed concrete reactor vessel (PCRV) structure with its reinforcing steel and prestressing components; liners, penetrations, closures, and cooling water tubes attached to the concrete side of the liner; the thermal barrier (insulation) on the primary coolant side of the liner; instrumentation for structural monitoring; and a pressure relief system. Specifications are presented.

4638 **(GA-A—16538) HTGR applications program. Semiannual report, April 1, 1981-September 30, 1981.** (GA Technologies, Inc., San Diego, CA (USA)). Mar 1982. Contract AT03-76SF70046. 603p. NTIS, PC A99/MF A01. Order Number DE84001643.

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Technical progress on four variants of the high-temperature gas-cooled reactor (HTGR) is presented with emphasis on the nuclear heat source for the steam cycle cogeneration application. This report describes (1) the advancement of the 2240-MW(t) HTGR-SC/C nuclear heat system and component design; (2) resolution of priority tehnical issues; (3) recommendations on enhanced safety features for the HTGR-SC/C reference design; (4) preparation of long-range program plans; and (5) results of studies on the design development of the HTGR process heat direct and indirect cycle nuclear heat source. Details of an alternate core support concept for the HTGR process heat application are given, and a conceptual design investigation for a new 250-MW(t) HTGR modular reactor system for process heat application is described. Studies on the application of the HTGR-SC/C for synfuel production are included, along with technology, cost, safety, and plant operability evaluations of the direct and indirect cycle HTGR sensible energy transportation and storage systems. The HTGR high-temperature process heat application is also presented.

22 NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 4798

4639 **Current research and development at the Karlsruhe Nuclear Research Center.** Kuesters, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). pp 43 of Waste management in nuclear facilities. Abstracts. Karlsruhe, Germany, F.R.; Kernforschungszentrum Karlsruhe G.m.b.H. (1982). (CONF-8209134—Absts.).

From IAEA interregional training course on waste management in nuclear facilities; Karlsruhe, F.R. Germany (6 Sep 1982).

2201 Theory And Calculation

REFER ALSO TO CITATION(S) 4762, 5504, 5531

4640 **(ANL/RERTR/TM—4, pp 313-321) Comparison of calculations and measurements of MEU fuel in the SAPHIR-Reactor.** Winkler, H.; Zeis, J. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen, Switzerland). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

In order to check the validity of the calculations codes used for the reduced enrichment program some reactivity measurements have been done on the SAPHIR-Reactor. In a 4 x 4 core arrangement each standard element (93% enrichment approximately 280 g U-235, 23 plates) has been replaced by an element with 320 g U-235, 45% enrichment. The reactivity difference has been determined over the fine control rod position. The same core configuration was calculated with the two dimensional diffusion code CODIFF in order to obtain the difference in k/sub eff/ resp. rho. It is shown that the mean deviation between calculation and measurement is less than 6.5%. Thus reasonable agreement exists.

2202 Components And Accessories

REFER ALSO TO CITATION(S) 4765, 4766, 4799, 4800, 4801, 4803, 4804, 4805

4641 **(ANL—83-72) Dynamics of tubes in fluid with tube-baffle interaction.** Chen, S.S.; Jendrzejczyk, J.A.; Wambsganss, M.W. (Argonne National Lab., IL (USA)). Sep 1983. Contract W-31-109-ENG-38. 89p. NTIS, PC A05/MF A01. Order Number DE84001452.

Three series of tests are performed to evaluate the effects of tube to tube-support-plate (TSP) clearance on tube dynamic characteristics and instability phenomena for tube arrays in crossflow. Test results show that, for relatively large clearances, tubes may possess TSP-inactive modes in which the tubes rattle inside some of the tube-support-plate holes, and that the natural frequencies of TSP-inactive modes are lower than those of TSP-active modes, in which the support plates provide knife-edge type support. Tube response characteristics associated with TSP-inactive modes are sensitive to tube-to-TSP clearance, TSP thickness, excitation amplitude, tube alignment, and the fluid inside the clearance. In addition, tube response is intrinsically nonlinear, with the dominance of TSP-inactive or TSP-active modes depending on the magnitudes of different system parameters. In general, such a system is difficult to model; only a full-scale test can provide all the necessary characteristics. A tube array supported by TSPs with relatively large clearances may be subjected to dynamic instability in some of the TSP-inactive modes; tube response characteristics and impact forces on TSPs for a tube row are studied in detail in this report. Tube displacements associated with the instability of a TSP-inactive mode are small; however, impacts of the tube against TSPs may result in significant damage in a relatively short time. 52 figures.

4642 **(ANL-CT—83-6) Interim report on the state-of-the-art of solid-state motor controllers. Part 4. Failure-rate and failure-mode data.** Jaross, R.A. (Argonne National Lab., IL (USA)). Sep 1983. Contract W-31-109-ENG-38. 26p. NTIS, PC A03/MF A01. Order Number DE84001022.

An assessment of the reliability of solid-state motor controllers for nuclear power plants is made. Available data on failure-rate and failure-mode data for solid-state motor controllers based on industrial operating experience is meager; the data are augmented by data on other solid-state power electronic devices that are shown to have components similar to those found in solid-state motor controllers. In addition to large nonnuclear solid-state adjustable-speed motor drives, the reliability of nuclear plant inverter systems and high-voltage solid-state dc transmission-line converters is assessed. Licensee Event Report analyses from several sources, the open literature, and personal communications are used to determine the

realiability of solid-state devices typical of those expected to be used in nuclear power plants in terms of failures per hour.

4643 **(CONF-8310143—54) Computational methods for fracture analysis of heavy-section steel technology (HSST) pressure vessel experiments.** Bass, B.R.; Bryan, R.H.; Bryson, J.W.; Merkle, J.G. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 51p. NTIS, PC A04/MF A01. Order Number DE84003327.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

This paper summarizes the capabilities and applications of the general-purpose and special-purpose computer programs that have been developed for use in fracture mechanics analyses of HSST pressure vessel experiments. Emphasis is placed on the OCA/USA code, which is designed for analysis of pressurized-thermal-shock (PTS) conditions, and on the ORMGEN/ADINA/ORVIRT system which is used for more general analysis. Fundamental features of these programs are discussed, along with applications to pressure vessel experiments.

4644 **(INIS-mf—8418) Layout of the components: Component layout (class II and III).** Schabert, H.P. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 21p. (CONF-8109220—18). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703294.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

In the present paper nuclear auxiliary components are described with reference to their functional layout, mechanical design, manufacture and quality assurance.

4645 **(INIS-mf—8465) Manufacture of heavy reactor components with particular consideration to quality assurance.** Kreppel, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 38p. (CONF-8109220—21). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703300.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The use of adequate quality assurance measures is one of the most important prerequisites for the manufacture of reactor components. Nature and extent of the quality assurance system at present adopted in the Federal Republic of Germany are illustrated, using the manufacture of a reactor pressure vessel as an example. The system comprises quality organization, planning of all quality assurance measures, quality surveillance through all stages of manufacture and documentation of quality attained.

4646 **Prestressed concrete pressure vessels and their applicability to advanced energy system concepts.** Naus, D.J. (Oak Ridge National Laboratory, Oak Ridge, TN). *American Society of Mechanical Engineers, [Paper];* No. 83-NE-1, 6(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

Prestressed concrete pressure vessels (PCPVs) are, in essence, spaced steel structures since their strength is derived from a multitude of steel elements made up of deformed reinforcing bars and prestressing tendons which are present in sufficient quantities to carry tension loads imposed on the vessel. Other major components of a PCPV include the concrete, liner and cooling system, and insulation. PCPVs exhibit a number of advantages which make them ideally suited for application to advanced energy concepts: fabricability in virtually any size and shape using available technology, improved safety, reduced capital costs, and a history of proven performance. PCPVs have many applications to both nuclear- and non-nuclear-based energy systems concepts. Several of these concepts are discussed as well as the research and development activities conducted at ORNL in support of PCPV development.

4647 **Overview of cooperative international piping benchmark analyses.** McAfee, W.J. (Oak Ridge National Laboratory, Oak Ridge, TN). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL-56**: 79-98(1983). (CONF-820601—). Contract W-7405-ENG-26.

This paper presents an overview of an effort initiated in 1976 by the International Working Group on Fast Reactors (IWGFR) of the International Atomic Energy Agency (IAEA) to evaluate detailed and simplified inelastic analysis methods for piping systems with particular emphasis on piping bends. The procedure was to collect from participating member IAEA countries descriptions of tests and test results for piping systems or bends (with emphasis on high temperature inelastic tests), to compile, evaluate, and issue a selected number of these problems for analysis, and to compile and make a preliminary evaluation of the analyses results. The Oak Ridge National Laboratory coordinated this activity, including compilation of the original problems and the final analyses results. Of the problem descriptions submitted, three were selected to be used. These were issued in December 1977. As a follow-on activity, addenda were issued that provided additional data or corrections to the original problem statement. A variety of both detailed and simplified analysis solutions was obtained. A brief comparative assessment of the analyses is contained in this paper.

4648 **Ultimate pressure capacity analysis of a post-tensioned reinforced concrete nuclear reactor containment building.** Dooley, W.T.; Macek, R.W.; Sadik, S. (EG & G Idaho Inc., Idaho Falls, Idaho). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 76**: 89-98(1983). (CONF-830607—). Contact AC07-76ID01570.

This paper presents a three dimensional nonlinear structural analysis of a post-tensioned reinforced concrete nuclear reactor containment building. The objective of the analysis was to develop and demonstrate modeling techniques appropriate for determining the global ultimate internal pressure capacity of this type of containment. The structural model developed for the ADINA computer code employed nonlinear material models with truss, shell and three dimensional continuum elements to represent the major structural members (tendons, rebars, ties, concrete and liner). In addition a special uniaxial elastic plastic shell material model was developed to facilitate representation of the dome tendon lacing pattern. Effective use of symmetry permitted all three dimensional effects to be represented in a 30° (0.52 rad) segment of the structure. The analysis suggested that gross failure of the structure at a quasistatic internal pressure of 99 psi (0.68 MPa) may have been precipitated by the nonaxisymmetric three dimensional nature of the stress field in the concrete near the tendon anchorages.

4649 **Seismic evaluation of a large nuclear pump bearing using non-linear dynamic analysis.** Huber, K.A.; Hugins, M.S. (Energy Systems Development Center, Byron Jackson Pump Division, Borg-Warner Corporation, Carson, California). *American Society of Mechanical Engineers, [Paper];* No. 83-PVP-52, 8(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

Hydrostatic bearings of a large vertical pump using sodium as the lubricant were critically examined to determine their ability to withstand seismic loads. Initial linear dynamics analyses predicted journal displacements to exceed bearing clearance by a ratio of 3:1. Equivalent time-history excitations were then developed from the response spectra to determine the number, magnitude, and duration of the bearing impact loads. Predicted loads were further reduced by 50% by modeling non-linear bearing characteristics normally present but not generally included in conventional linear analyses. Results are presented of the comprehensive design evaluation performed, based on these non-linear predictions, that assess stress, wear, and fatigue to demonstrate hydrostatic bearing integrity.

4650 **An analysis of dynamic crack propagation and arrest in a nuclear pressure vessel under thermal shock conditions.** Jung, J.; Kanninen, M.F. (Sandia National Laboratory, Albuquerque, NM). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 58**: 91-108(1982). (CONF-820601—).

The inner wall of a nuclear pressure vessel can become embrittled during service due to irradiation effects. As a result, a small flaw could become critical during the thermal shock that would accompany a loss-of-coolant-accident. To assess the consequences of this possibility, elastodynamic computations were performed on the subsequent rapid unstable crack run-arrest events. One difficulty is the lack of reliable dynamic fracture toughness data as a function of crack speed and temperature. However, using plausible estimates, computational results were obtained for comparison with conventional quasi-static analyses. These indicate that the neglect of the dynamic effects is mildly anti-conservative for this application.

4651 **Hierarchically structured identification and classification method for vibrational monitoring of reactor components.** Saedtler, E. Muenchen, Germany, F.R.; Technische University (1981). 264p. (In German). Library of Technische Univ. Muenchen (Germany, F.R.).

Thesis (Ph.D.).

The dissertation discusses: approximative filter algorithms for identification of systems and hierarchical structures; adaptive statistical pattern recognition and classification; parameter selection, extraction, and modelling for an automatic control system; and design of a decision tree and an adaptive diagnostic system.

2203 Fuel Elements

REFER ALSO TO CITATION(S) 4676, 4677, 4678, 4687, 4688

4652 (ANL/RERTR/TM—4, pp 75-78) **Irradiation program of highly loaded UAl_2-Al fuel plates.** Brown, K.R. (EG & G Idaho, Inc., Idaho Falls). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

An irradiation test program was conducted to confirm the performance of high-uranium-density loaded fuel plates at high burnup using UAl/sub x/-Al dispersion fuels. Although the program is being conducted with fuel plates containing 93% enriched uranium, the results are applicable to medium- and low-enriched uranium. No correlation could be established between failed plates and either burnup or plate fuel composition when the plates were removed prior to target burnup due to a fission product release to the ATR primary coolant system. The irradiation test was reinserted to obtain target burnup.

4653 (ANL/RERTR/TM—4, pp 149-152) **Aluminum-U_3O_8 exothermic reaction.** Copeland, G.L. (Oak Ridge National Lab., TN). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—). Contract W-7405-ENG-26.

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The phase assemblage of aluminum-urania is a nonequilibrium mixture and a cermet fuel of this mixture will ultimately tend to change phases. Early studies of this reaction recognized the potentially large energy release accompanying the phase change. This paper reviews the studies of the reaction and concludes that increasing the uranium content to the level necessary for low-enriched fuels will not add significantly to the chemical reaction hazard.

4654 (ANL/RERTR/TM—4, pp 155-170) **C.E.R.C.A. contribution to the RERTR program: status of development, November 1982.** Savornin, B.; Fanjas, Y.R. Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

CERCA is in a position to provide on industrial scale UAl/sub x/, U_3O_8, and U_3Si_2 fuels with uranium densities up to 5 g/cm³. For densities between 5 and 7.4 g/cm³, pilot technology is available. Development being carried out towards industrialization of U_3Si fuel production is described.

4655 (ANL/RERTR/TM—4, pp 171-182) **Recent status and future aspect of plate type fuel element technology with high uranium density at NUKEM.** Hrovat, M.F.; Hassel, H.W. (NUKEM GmbH., Hanau, Germany). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

According to the present state of development, full size test fuel elements with UAl/sub x/, U_3O_8, and U_3Si_2 fuel were fabricated at Nukem in production scale. The maximum uranium densities amount to 1.8 g/cm³ for UAl/sub x/, 2.9 g/cm³ for U_3O_8, and 4.76 g/cm³ for U_3Si_2. The irradiation performance of these fuel elements is good: Up to the end of September 1982 the following burnups were achieved: 73% with UAl/sub x/, 60% with U_3O_8, 39% with U_3Si_2; no defects could be detected. For an economical fuel element production with reduced ^{235}U enrichment chemical uranium recycling methods were developed allowing immediate scrap recovery at minimum waste generation. In addition test plates with UAl/sub x/ and U_3O_8 fuel were successfully irradiated in the ORR up to a burnup of 75%. The relatively high uranium meat densities of these test plates amount to 2.2 g/cc for UAl/sub x/, and 3.14 g/cc for U_3O_8 fuel. Apart from plates with standard geometry also plates with increased meat thickness were inserted.

4656 (CONF-8310144—3-Rev.) **Mechanistic prediction of fission product release under normal and accident conditions: key uncertainties that need better resolution.** Rest, J. (Argonne National Lab., IL (USA)). Sep 1983. Contract W-31-109-ENG-38. 44p. NTIS, PC A03/MF A01. Order Number DE84003715.

From Specialists' workshop on fission gas behavior in safety experiments; Cadarache, France (5 Oct 1983).

A theoretical model has been used for predicting the behavior of fission gas and volatile fission products (VFPs) in UO_2-base fuels during steady-state and transient conditions. This model represents an attempt to develop an efficient predictive capability for the full range of possible reactor operating conditions. Fission products released from the fuel are assumed to reach the fuel surface by successively diffusing (via atomic and gas-bubble mobility) from the grains to grain faces and then to the grain edges, where the fission products are released through a network of interconnected tunnels of fission-gas induced and fabricated porosity. The model provides for a multi-region calculation and uses only one size class to characterize a distribution of fission gas bubbles.

2204 Control Systems

REFER ALSO TO CITATION(S) 5348

4657 (EGG-M—15483) **Potential utilities of optimal estimation and control in nuclear power plants.** Tylee, J.L.; Purviance, J.E. (EG and G Idaho, Inc., Idaho Falls (USA); Idaho Univ., Moscow (USA). Dept. of Electrical Engineering). 1983. Contract AC07-76ID01570. 9p. (CONF-8310102—3). NTIS, PC A02/MF A01. Order Number DE84002225.

From Instrument Society of America conference and exhibit; Houston, TX, USA (10 Oct 1983).

Optimal estimation and control theories offer the potential for more precise control and diagnosis of nuclear power plants. The important element of these theories is that a mathematical plant model is used in conjunction with the actual plant data to optimize some performance criteria. These criteria involve important plant variables and incorporate a sense of the desired plant performance. Several applications of optimal estimation and control to nuclear systems are discussed.

4658 **(EGG-M—21983) Evaluation guidelines for microprocessor-based systems important to safety.** Adams, D.M.; Svoboda, J.M. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 16p. (CONF-8310143—45). NTIS, PC A02/MF A01. Order Number DE84002203.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

Proposed criteria for the application of stored-program, digital computers in commercial nuclear power plants are presented in summary form. The emphasis is on making recommendations for the design of computer systems and on recommending a method for the regulatory review of computer system designs. More-restrictive requirements are made for protection systems than control systems or other plant computer systems. In making these recommendations, the study team reviewed current regulations, past NRC reviews of computer systems, the work done by other government agencies, and the work done by many other countries. The results provide a classification of systems, a recommended design method, and a specification of design issues to be resolved during the design and development of digital computer systems.

4659 **(EGG-M—22083) Fault diagnosis using artificial intelligence.** Bray, M.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 10p. (CONF-8310143—46). NTIS, PC A02/MF A01. Order Number DE84002632.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

An experiment was performed during 1983 that measured performance of nuclear plant operators with and without a computer-based operator aid. This paper discusses the results of that experiment and implications for design and regulation of advanced computer aids in nuclear control rooms.

4660 **(INIS-mf—8412) Instrumentation and control circuit.** Spieth, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 19p. (CONF-8109220—22). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703301.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

Nuclear power plants need a variety of different measurements. Their principal structure and general design is presented. Examples of nuclear measurements are handled in more detail. The hierarchy of binary control is shown. Typical function group control is explained. As an example for analog control circuits the Integrated Control System for reactor, steam generator and turbine is explained. Task and design of on-line computers are shown. Man-machine interfacing is handled on the example of the control room. Some design criteria are given.

4661 **(INIS-mf—8437) Control room design and human engineering in power plants.** Herbst, L.; Hinz, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 39p. (CONF-8109220—20). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703296.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

Automation reduces the human work load. Employment of functional areas permits optimization of operational sequences. Computer based information processing makes it possible to output information in accordance with operating requirements. Design based on human engineering principles assures the quality of the interaction between the operator and the equipment. The degree to which these conceptional features play a role in design of power plant control rooms depends on the unit rating, the mode of operation and on the requirements respecting safety and availability of the plant.

4662 **(NUREG/CR—3415) Nuclear power plant control-room task analysis: pilot study for boiling-water reactors.** Barks, D.B.; Gomer, F.E.; Kozinsky, E.J.; Moody, G.F. (Oak Ridge National Lab., TN (USA); General Physics Corp., Chattanooga, TN (USA); General Physics Corp., Dayton, OH (USA)). Sep 1983. Contract W-7405-ENG-26. 129p. NTIS, PC A07/MF A01 - GPO. Order Number DE84000861.

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This report presents the results of the second phase of a two-phase project undertaken to develop a more detailed understanding of the manner in which control room crews perform assigned tasks when mitigating plant malfunctions. Phase II had these objectives: (1) apply the task analysis (TA) methodology developed in Phase I for assessing pressurized water reactor (PWR) crews to create a data base for boiling water reactor (BWR) crews; (2) show how objective data collected during high-fidelity simulation runs can be used to augment TA data collected concurrently; (3) examine additional objective measures of operator performance; and (4) begin to apply the TA data to the development of predictive models of operator/system performance. Ten plant malfunctions were presented to two-man crews on a Boiling Water Reactor training simulator. Videotaped records of all simulation runs, written operating procedures, interviews, and talk-throughs were data sources for the entry of task analysis information into a computer-searchable data base.

2205 Environmental Aspects

REFER ALSO TO CITATION(S) 4465, 4611, 4612, 4623, 4624

4663 **(INIS-mf—8445) Geology and seismology.** Schneider, J.F.; Blanc, B. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 54p. (CONF-8009308—49). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703284.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

For the construction of nuclear power stations, comprehensive site investigations are required to assure the adequacy and suitability of the site under consideration, as well as to establish the basic design data for designing and building the plant. The site investigations cover mainly the following matters: geology, seismology, hydrology, meteorology. Site investigations for nuclear power stations are carried out in stages in increasing detail and to an appreciable depth in order to assure the soundness of the project, and, in particular, to determine all measures required to assure the safety of the nuclear power station and the protection of the population against radiation exposure. The aim of seismological investigations is to determine the strength of the vibratory ground motion caused by an expected strong earthquake in order to design the plant resistant enough to take up these vibrations. In addition, secondary effects of earthquakes, such as landslides, liquefaction, surface faulting, etc. must be studied. For seashore sites, the tsunami risk must be evaluated.

4664 **(N—8326161) Ground truth sampling and LANDSAT accuracy assessment.** Robinson, J.W. (Computer Sciences Corp., Greenbelt, Md.); Gunther, F.J. (Computer Sciences Corp., Greenbelt, Md.); Campbell, W.J. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). 1982. 14p. NTIS, PC A14/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 1 p 69-82 (SEE N83-26155 15-43).

It is noted that the key factor in any accuracy assessment of remote sensing data is the method used for determining the ground truth, independent of the remote sensing data itself. The sampling and accuracy procedures developed for nuclear power plant siting study are described. The purpose of the sampling procedure was to provide data for developing supervised classifications for two study sites and for assessing the accuracy of that and the other procedures used. The purpose of the accuracy assessment was to allow the comparison of the cost and accuracy of various classification procedures as applied to various data types.

4665 **(N—8326182) Impact of demographic siting criteria and environmental suitability on land availability for nuclear reactor siting.** Hansen, K.L. (Dames and Moore, Los Angeles, CA (USA)). 1982. 20p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 373-392 (SEE N83-26176 15-43).

The effect of population and certain environmental characteristics on the availability of land for siting nuclear power plants was assessed. The study area, consisting of the 48 contiguous states, was divided into 5 kilometer (km) square grid cells yielding a total of 600,000 cells. Through the use of a modern geographic information system, it was possible to provide a detailed analysis of a quite large area. Numerous maps and satatistical tables were produced, the detail of which were limited only by available data. Evaluation issues included population density, restricted lands, seismic hardening, site preparation, water availability, and cost factors.

4666 **(N—8326185) Potential role of land use and land cover information in powerplant siting: Example of Three Mile Island.** Wray, J.R. (Geological Survey, Reston, VA (USA)). 1982. 17p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 427-431 (SEE N83-26176 15-43).

Selecting a site for a nuclear powerplant can be helped by digitizing land use and land cover data, population data, and other pertinent data sets, and then placing them in a geographic information system. Such a system begins with a set of standardized maps for location reference and then provides for retrieval and analysis of spatial data keyed to the maps. This makes possible thematic mapping by computer, or interactive visual display for decision-making. It also permits correlating land use area measurements with census and other data (such as fallout dosages), and the updating of all data sets. The system is thus a tool for dealing with resource management problems and for analyzing the interaction between people and their environment. An explanation of a computer-plotted map of land use and cover for Three Mile Island and vicinity is given.

4667 **(N—8326195) Energy facility siting by means of environmental modelling with LANDSAT, Thematic Mapper and Geographic Information System (GIS) data.** (Pennsylvania Power and Light Co., Allentown (USA)). 1982. 3p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 538-540 (SEE N83-26176 15-43).

Currently based on ground and aerial surveys, the land cover data base of the Pennsylvania Power and Light Company is routinely used for modelling the effects of alternative generating plant and transmission line sites on the local and regional environment. The development of a satellite-based geographic information system would facilitate both the preparation of environmental impact statements by power companies and assessment of the data by the Nuclear Regulatory Commission. A cooperative project is planned to demonstrate the methodology for integrating satellite data into an existing geographic information system, d to further evaluate the ability of satellite data in modeling environmental conditions that would be applied in the preparation and assessment of environmental impact statements.

4668 **Nuclear power: Reprocessing - part of radioactive waste disposal. Comments on the grey brochure of the Bavarian Environmental Minister.** Bamburg, German, F.R.; Bildungswerk Bund Naturschutz in Bayern e.V. (1982). 75p. (In German). Bildungswerk Bund Naturschutz in Bayern e.V., Bamberg (Germany, F.R.).

The brochure of the "Bund Naturschutz in Bayern" examines the major statements of the Bavarian Environmental Minister as to their content of truth. It wants to provide a concrete basis for discussions to the interested citizen, but also to representatives of authorities and political parties. First of all brief comments are made on the six statements "nuclear energy is necessary", "nuclear energy is harmless to the environment", "large-scale technical experiences in reprocessing are already available", "reprocessing is reasonable from the ecological point of view", "reprocessing is reasonable from the economic point of view", "nuclear power povides jobs". In an annexed part these statements are then explained in detail giving data and particulars.

2206 Research, Test, And Experimental Reactors

REFER ALSO TO CITATION(S) 4608, 4624, 4625, 4626, 4688, 4694, 4713, 4720, 4761

4669 **(ANL/RERTR/TM—4) Proceedings of the international meeting on research and test reactor core conversions from HEU to LEU fuels.** (Argonne National Lab., IL (USA)). Sep 1983. Contract W-31-109-ENG-38. 709p. (CONF-821155—). NTIS, PC A99/MF A01. Order Number DE84001697.

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

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Separate abstracts have been prepared for each paper presented in the following areas of interest: (1) fuel development; (2) post-irradiation examinations; (3) reprocessing; (4) thermite reaction; (5) fuel fabrication; (6) element tests; (7) core tests; (8) criticals; (9) shipping; and (10) reactors and methods.

4670 (ANL/RERTR/TM—4, pp 9-23) **Status of the German AF-programme: considerations with respect to INFCE recommendations and criteria.** Thamm, G.H. (Kernforschungsanlage Juelich GmbH, Germany). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Essential conditions in the form of criteria were elaborated by the INFCE Working Group 8C in connection with the recommendation for enrichment reduction in research reactors. These criteria are: (1) the safety margins and fuel reliability should not be reduced by a conversion from HEU to LEU cycles; (2) losses in reactor performance (e.g., the ratio of neutron flux available for experiments) to reactor power should not be more than marginal; (3) the cost of conversion for research reactors should be kept as low as possible; (4) any increase in operating costs after conversion should not be more than marginal. This paper describes how the first three criteria mentioned have been given particular attention and have a good chance of being complied with in the current worldwide development activities for a conversion of research reactors to LEU fuel cycle operation. The prospects are much more unfavorable for the 4th criterion of keeping increases in operating costs at a minimum.

4671 (ANL/RERTR/TM—4, pp 24-32) **Reducing enrichment program for research reactors in Japan.** Kanda, K. (Kyoto Univ., Japan). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

This paper reviews the reducing enrichment program in Japan until now. Tables show the following: research reactors and critical assemblies in operation in Japan; their relationship to the reducing enrichment program; joint study with Argonne National Laboratory (ANL); critical experiments using the Kyoto University Critical Assembly (KUCA); schedule for the Kyoto University High Flux Reactor (KUHFR) conversion; Japan Atomic Energy Research Institute (JAERI) program; and preparation for critical experiments using the Japan Material Test Reactor Critical Facility (JMTRC).

4672 (ANL/RERTR/TM—4, pp 47-56) **Development of U_6Fe-Al dispersions for the use of LEU in research and test reactors.** Nazare, S. (Kernforschungszentrum Karlsruhe, Germany). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

For some time now, efforts are being made to develop fuel dispersions that would permit the use of low (~ 20% 235-U) en-

riched uranium (LEU) instead of the currently used highly (~ 93% 235-U) enriched uranium (HEU) in research and test reactors. Since penalties in the performance of the reactor have to be avoided, the 235-U content in the dispersion has at least to be retained at current levels. On account of their high U-densities, the major development effort has been focussed on the uranium silicides (U_3Si, $U_3Si(Al)$, and U_3Si_2-based dispersions). With silicides as dispersants, it is possible to fabricate fuel element plates with U-densities in the dispersion of about 6.0 gU/cm³. In comparison to the silicides, the U_6Fe-phase offers several advantages namely: higher U-density (~ 17.0 gU/cm³); relative ease of formation compared to U_3Si; possible advantages with regard to reprocessing of the spent fuel due to the absence of silicon. The studies outlined here were performed with a view to investigating the preparation, reaction behavior and dimensional stability after heat treatment of U_6Fe-Al dispersions.

4673 (ANL/RERTR/TM—4, pp 134-137) **Dissolution and clarification of RERTR silicide fuels.** Rodrigues, G.C. (E.I. du Pont de Nemours & Co., Aiken, SC). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—). Contract AC09-76SR00001.

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Savannah River Plant may reprocess spent RERTR fuel as early as FY-85. Candidate RERTR fuels include uranium oxides, aluminides, and silicides. Much less is known about the behavior of uranium silicides during Purex reprocessing than either uranium oxides or aluminides. Studies were performed at SRL with RERTR silicide fuels to ensure their reprocessability. The results of dissolution and head-end clarification studies with both unirradiated and irradiated fuel are presented.

4674 (ANL/RERTR/TM—4, pp 138-148) **Solvent extraction studies of RERTR silicide fuels.** Gouge, A.P. (E.I. du Pont de Nemours & Co., Aiken, SC). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—). Contract AC09-76SR00001.

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Uranium silicide fuels, which are candidate RERTR fuel compositions, may require special considerations in solvent extraction reprocessing. Since Savannah River Plant may be reprocessing RERTR fuels as early as 1985, studies have been conducted at Savannah River Laboratory to demonstrate the solvent extraction behavior of this fuel. Results of solvent extraction studies with both unirradiated and irradiated fuel are presented along with the preliminary RERTR solvent extraction reprocessing flow sheet for Savannah River Plant.

4675 (ANL/RERTR/TM—4, pp 183-192) **History of Research Reactor Fuel Fabrication at Babcock & Wilcox.** Freim, J.B. (Babcock & Wilcox, Lynchburg, VA). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

1982 was a year of tremendous growth for Babcock & Wilcox and its Research Reactor Fuel Facility. The Division has progressed from essentially being a non-competitor to a position where we are growing in strength. This paper describes some of the general aspects of past history and where B & W is now.

4676 (ANL/RERTR/TM—4, pp 193-197) **Uranium silicide activities at Babcock & Wilcox.** Noel, W.W.; Freim, J.B. (Babcock & Wilcox, Lynchburg, VA). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Babcock & Wilcox, Naval Nuclear Fuel Division (NNFD) in conjunction with Argonne National Laboratory (ANL) is actively involved in the Reduced Enrichment Research Test Reactor (RERTR) Program to produce low enriched fuel elements for research reactors. B & W and ANL have undertaken a joint effort in which NNFD will fabricate two low enriched uranium (LEU), Oak Ridge Reactor (ORR) elements with uranium silicide fuel furnished by ANL. These elements are being fabricated for irradiation testing at Oak Ridge National Laboratory (ORNL). Concurrently with this program, NNFD is developing and implementing the uranium silicide and uranium aluminide fuel fabrication technology. Development and production of the uranium silicide elements are discussed.

4677 (ANL/RERTR/TM—4, pp 198-205) **Current status of U-ZrH LEU fuel experiments in the ORR.** West, G.B. (GA Technologies Inc., San Diego, CA). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The TRIGA-LEU fuel cluster undergoing irradiation in the ORR has now completed over 600 full power days (FPD) of operation. Testing of the U-ZrH fuel began in December 1979 under the RERTR program administered by Argonne National Laboratory and two of the three different fuel loadings (20 and 30 wt % U) have successfully completed their test design burnup values and have been removed from the cluster. Approximately another year of irradiation will be necessary to achieve the test design burnup on the fuel with the highest loading (45 wt % U). The fuel rods have been very stable during the entire irradiation with no problems being evident to date.

4678 (ANL/RERTR/TM—4, pp 305-312) **Argentine activities related to the development of low enriched fuel elements.** Giorsetti, D.R.; Perez, E.E. (Comision Nacional de Energia Atomica, Buenos Aires, Argentina). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Within the framework of the RERTR Program and supported by the technical cooperation work agreed upon between the USA and Argentina in May 1979, the CNEA Nuclear Fuel Department - Low Enriched Fuel Elements Project (ECBE Project) has carried on its own program for developing fuels with low enrichment for research and test reactors. Up to the present, its main objective has been to replace the highly enriched fuel used in its only reactor (RA-3) for research, development and radioisotopes production. The basic stages of the Argentine Program are shown. The densities reached were within the range of 3.12 to 3.58 g/cm³ for U_3O_8-Al, 2.99 to 3.09 g/cm³ for UAl_2-Al and 5.18 to 6.10 g/cm³ for U_3Si-Al. If further miniplates can be irradiated, it is the purpose of the program to research uranium densities of 3.5 g/cm³ in UAl_2-Al and 6.5 g/cm³ in U_3Si-Al.

4679 (ANL/RERTR/TM—4, pp 462-471) **Analysis of KUCA MEU cores by the JAERI SRAC code system.** Mori, T.; Tsuchihashi, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

As a part of Japanese RERTR program, a series of calculations have been done for the KUCA critical experiments using MEU fuel by the code system SRAC which has been developed since 1978 as the nuclear design and analysis part of the JAERI standard thermal reactor code system. This report describes a preliminary analysis of the data measured in the fiscal year of 1981 by the current data library of the SRAC.

4680 (ANL/RERTR/TM—4, pp 483-490) **Administrative mechanics of research fuel transportation.** Harmon, D.W. (Edlow International Co., Washington, DC). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The administrative mechanics that have to be meshed for the successful completion of a shipment of spent research fuel are discussed. The following topics are covered: quotation phase, trans-

port routing, routing restrictions and regulations, security, costs, operations, and public relations.

4681 (ANL/RERTR/TM—4, pp 491-500) **Research reactor fuel transport in the UK.** Panter, R. (United Kingdom Atomic Energy Authority, Harwell). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

This paper describes the containers currently used for transport of fresh or spent fuel elements for Research and Materials Test Reactors in the UK, their status, operating procedures and some of the practical difficulties. In the UK, MTR fuel cycle work is almost entirely the responsibility of the UK Atomic Energy Authority.

4682 (ANL/RERTR/TM—4, pp 543-549) **Shutdown requirements in licensing of research reactors and consequences for operation.** Roegler, H.J.; Stein, J. (Internationale Atomreaktorbau GmbH, Bergisch Gladbach, Germany). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

One of the confusing points of the existing IAEA-regulations is the lengthy discussion of reactivity considerations for critical assemblies first, no similar separate discussion for research reactors and a second discussion titled control-rod considerations under the main title considerations applying to critical assemblies and research reactors. This discussion is restricted to the latter since the critical assemblies with their timely constance of maximum excess reactivity do not present any problem for all shut-down conditions.

4683 (ANL/RERTR/TM—4, pp 654-680) **Selection and benchmarking of computer codes for research reactor core conversions.** Yilmaz, E. (Univ. of Oklahoma, Norman); Jones, B.G. Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

A group of computer codes have been selected and obtained from the Nuclear Energy Agency (NEA) Data Bank in France for the core conversion study of highly enriched research reactors. ANISN, WIMSD-4, MC², COBRA-3M, FEVER, THERMOS, GAM-2, CINDER and EXTERMINATOR were selected for the study. For the final work THERMOS, GAM-2, CINDER and EXTERMINATOR have been selected and used. A one dimensional thermal hydraulics code also has been used to calculate temperature distributions in the core. THERMOS and CINDER have been modified to serve the purpose. Minor modifications have been made to GAM-2 and EXTERMINATOR to improve their utilization. All of the codes have been debugged on both CDC and IBM computers at the University of Illinois. IAEA 10 MW Benchmark problem has been solved. Results of this work has been compared with the IAEA contributor's results. Agreement is very good for highly enriched fuel (HEU). Deviations from IAEA contributor's mean value for low enriched fuel (LEU) exist but they are small enough in general.

4684 (HEDL-SA—2865-FP) **Fast-neutron fluence spectra and integral reaction rates determined with nuclear research emulsions.** Roberts, J.H.; Gold, R.; Ruddy, F.H.; Preston, C.C.; McNeece, J.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1983. Contract AC06-76FF02170. 19p. (CONF-830969—4). NTIS, PC A02/MF A01. Order Number DE84001485.

From 12. international conference on solid state nuclear track detectors; Acapulco, Mexico (4 Sep 1983).

Nuclear research emulsions are in use at the Westinghouse Hanford Company to characterize various neutron fields. Track measurements are accomplished with the use of an optical microscope interfaced with a computer. Whereas scanning by a person is still necessary, data is recorded in such a way that it is subject to many types of analyses. Examples given are the measurement of the spectrum-fluence of neutrons emitted in the spontaneous fission of ^{252}C/sub f/, the measurement of the spectrum-fluence of neutrons inside the core of a breeder reactor, and the measurement of two types of integral reaction rates in a reactor environment.

4685 **High temperature sodium testing of the CRBR prototype primary pump.** Tessier, M.J.; Grimaldi, J.L. (Rockwell International Corporation, Energy Technology Engineering Ctr., Santa Susana, CA). *American Society of Mechanical Engineers, [Paper];* No. 83-PVP-60, vp(1983). (CONF-830607—). Contract AC03-76SF00700.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

Qualification testing in sodium of the CRBR primary pump was conducted through 1982. This paper presents an overview of the test program, a description of the Sodium Pump Test Facility (largest of its kind in the world), a brief description of the test article and summary overview of results. Of special interest were the high temperature gas convection tests and the extensive flow/speed control (dynamic) tests. Special innovative test methods were employed to investigate these phenomena.

2207 Plutonium And Isotope Production Reactors

REFER ALSO TO CITATION(S) 4669, 4671, 4673, 4674, 4675, 4676, 4681, 4682, 4683, 4709, 4711

4686 (ANL/RERTR/TM—4, pp 57-74) **Development and testing of reduced enrichment fuels for Canadian research reactors.** Wood, J.C.; Foo, M.T.; Berthiaume, L.C. (Chalk River Nuclear Labs., Ontario). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Fuel rods of uranium silicide dispersed in aluminum and clad in aluminum have been developed and tested in the laboratory and in-reactor. The properties of the dispersion fuel materials proved satisfactory with regard to thermal conductivity, aqueous corrosion resistance, strength and ductility, and thermal stability below 473 K. A vacancy condensation model is proposed to account for the thermally-induced swelling that occurs above 473 K by virtue of the chemical reactions that occur between the dispersed silicide fuel particles and the aluminum matrix. The in-reactor fuel core swelling was less than 5% after irradiation at high powers (76-131 kW/m) to a high terminal burnup (79.2 at. % of U-235 atoms).

4687 (ANL/RERTR/TM—4, pp 206-241) **Status report on the irradiation of LEU-test elements in the Petten High Flux Reactor.** Pruimboom, H.; Swanenburg de Veye, R.J. (Netherlands Energy Research Foundation, Petten). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Within the framework of the RERTR-program four low enriched MTR-type fuel elements are irradiated in the HFR at Petten, The Netherlands. Two of these LEU test assemblies will be irradiated up to 50% burn-up, the two others up to 85%. The target burn-up level of 50% for two elements has been reached without any appreciable problem. The remaining two LEU-elements will reach 85% burn-up in the beginning of 1983. For the determination of the relevant irradiation characteristics of the test elements the following periodical investigations are carried out: coolant channel width measurements using an ultra-sonic probe; neutron metrology; reactivity measurements; and nuclear calculations (power, burn-up, neutron flux, thermal safety). After irradiation up to the specified burn-up levels all four LEU-test-elements will be subjected to extensive post-irradiation examination (PIE) in the Hot Laboratories. The first PIE operation will start in November 1982 on an LEU-element having 50% burn-up.

4688 (ANL/RERTR/TM—4, pp 242-253) **Qualification in the reactor SILOE of low enriched fuels for research and test reactors.** Merchie, F.; Baas, C.; Ploujoux, M. (Centre d'Etudes Nucleaires de Grenoble, France). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

For nearly two years now, in the scope of the Reduced Enrichment Research and Test Reactor (RERTR) Program, low enriched fuel has been irradiated in Siloe. In 1981, a complete 45% enriched fuel element (U Alx compound) was irradiated. A burn-up of 50% was obtained without any difficulty. Since June 1982, 4 U_3Si fuel plates are being irradiated. These plates, with a density of 5.5g of total uranium per cubic centimeter (two plates), and 6.0g per cubic centimeter (the other two plates) have already reached a mean burn-up of about 20% and their behavior till now is excellent. The fuel element and the plates have been manufactured by CERCA.

4689 (ANL/RERTR/TM—4, pp 325-334) **Research activities relevant to the application of LEU at the HOR.** van Dam, H.; de Vries, J.W. (Interuniversity Reactor Inst., Delft, Netherlands). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

Synoptic information is given concerning research activities at the Hoger Onderwijs Reactor (HOR), the results of which may be meaningful to the application of high-density, low enriched uranium fuel (LEU). The HOR, a 2 MW pool-type reactor, is one of the main research tools of the Interuniversity Reactor Institute (IRI), located at the campus of the Delft University of Technology, Netherlands. In the framework of a research program on the application of LEU at the HOR, the activities of both the Reactor Operations Group and the Reactor Physics Group of IRI are partially merged in a concerted effort to assess the consequences of core conversion. Part I deals with experimental results on fuel temperature measurements of a standard MTR-type fuel element, fitted with thermocouples in the fuel cladding. Part II gives an outline of programmed experimental research on the thermohydraulics of MTR-type fuel elements with an emphasis on detecting normal and off-normal cooling conditions.

4690 (ANL/RERTR/TM—4, pp 335-347) **FNR demonstration experiments. Part I. Beam port leakage currents and spectra.** Wehe, D.K.; King, J.S. (Univ. of Michigan, Ann Arbor). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The goal of the FNR-LEU experimental program has been to measure the changes in numerous reactor characteristics when the conventional HEU core is replaced by a complete LEU fueled core or by a single LEU element in the normal HEU core. We have observed comparisons in: (a) thermal flux intensity, spatial distribution and cadmium ratios, both in the core and in the light and heavy water reflectors; (b) fast flux intensity and spectral shape at a special element within the core; (c) the thermal leakage flux intensity at the exit positions of several beam ports and its spectral shape at one beam port; (d) shim and control rod worths; (e) temperature coefficient of reactivity; and (f) xenon poison worth.

4691 (ANL/RERTR/TM—4, pp 348-376) **FNR demonstration experiments. Part II. Subcadmium neutron flux measurements.** Wehe, D.K.; King, J.S. (Univ. of Michigan, Ann Arbor). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The FNR HEU-LEU Demonstration Experiments include a comprehensive set of experiments to identify and quantify significant operational differences between two nuclear fuel enrichments. One aspect of these measurements, the subcadmium flux profiling, is the subject of this paper. The flux profiling effort has been accomplished through foil and wire activations, and by rhodium self-powered neutron detector (SPND) mappings.

4692 (ANL/RERTR/TM—4, pp 377-396) **Analysis of the Ford nuclear reactor LEU core.** Rathkopf, J.A.; Drumm, C.R.; Martin, W.R.; Lee, J.C. (Univ. of Michigan, Ann Arbor). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The University of Michigan Department of Nuclear Engineering and the Michigan-Memorial Phoenix Project have been engaged in a cooperative effort with Argonne National Laboratory to test and analyze low enrichment fuel in the Ford Nuclear Reactor (FNR). The effort was begun in 1979, as part of the Reduced Enrichment Research and Test Reactor (RERTR) Program, to demonstrate on a whole-core basis, the feasibility of enrichment reduction from 93% to below 20% in MTR-type fuel designs. The focus of this paper is the analysis of the LEU core and prediction or simulation of the various measurements, such as critical mass, control rod worths, relative worths of LEU vs. HEU elements, and relative flux profiles in-core and ex-core. Comparisons between measured and calculated values are included wherever possible.

4693 (ANL/RERTR/TM—4, pp 479-482) **Transport of nuclear material (Part II).** Staake, T.; Schmidt, T. (Transnuklear GmbH, Hanau, Germany). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

In view of the future use of low enrichment fuel for MTR reactors, the transport of spent fuel has been investigated. The analysis shows that the existing casks can be utilized for this type of fuel. Each type of fuel, of course, requires an appropriate modification of package approval. Elements having substantially more U235 than those presently being shipped can be shipped by using modified basket inserts, if necessary.

4694 (ANL/RERTR/TM—4, pp 550-559) **Licensing aspect on JMTR MEU program and remodelling of JRR-3.** Sato, M.; Oyamada, R.; Miyasaka, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki). Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

JMTR is a 50 MW tank type research reactor cooled and moderated by pressurized light-water. Safety review for the JMTR core conversion from the HEU to the MEU fuels is now in progress. The moderations to be made to rectify LOCA and scenario for the hypothetical accident which is being revised are described in this paper. The hypothetical accident is being revised because of its inadequate scenario comparing with those of the current light water power reactors, as well as postulated accidents such as control rod withdrawal, etc., which are directly affected by the core conversion. JRR-3 is scheduled to be shutdown in 1983 and replaced with a 20MW pool-type reactor JRR-3(M) in 1987. Specifications of the JRR-3(M) are listed and compared with those of the present reactor. Low enrichment fuel will be used when it becomes available.

4695 (ANL/RERTR/TM—4, pp 627-653) **Neutronic calculations for the conversion of the University of Florida training reactor from HEU to LEU fuel.** Dugan, E.T. (Univ. of Florida, Gainesville); Kniedler, G.S.; Diaz, N.J. Sep 1983. NTIS, PC A99/MF A01. (CONF-821155—).

From International meeting on research and test reactor core conversions from HEU to LEU fuels; Argonne, IL, USA (8 Nov 1982).

The University of Florida Training Reactor (UFTR) is located on the University of Florida campus in Gainesville, Florida. The reactor is the Argonaut type, heterogeneous in design and currently fueled with 93% enriched uranium-aluminum alloy MTR plate-type fuel. Investigations are being performed to examine the feasibility of replacing the highly-enriched fuel of the current UFTR with 4.8% enriched, cylindrical pin SPERT fuel. The SPERT fuel is stainless steel clad and contains uranium dioxide

(UO_2) pellets. Physical descriptions and neutronic calculation results are presented.

4696 **(DPST—79-531) Use of cooling ponds and hydraulic turbines to save SRP energy consumption.** Price, J.B. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 19 Feb 1980. Contract AC09-76SR00001. 23p. NTIS, PC A02/MF A01. Order Number DE84002952.

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A substantial amount of energy can be saved by using cooling ponds to supply C and K reactors with cooling water. Hydraulic turbines between the reactor and the cooling pond can recover some of the power used to pump cooling water to the reactors. Cooling ponds would also reduce effluent temperature in the swamps adjacent to the Savannah River. Cooling ponds are evaluated in this memorandum.

4697 **(DPST—83-635) SRP process description for L reactor restart.** Johnson, D.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 22 Aug 1983. Contract AC09-76SR00001. 5p. NTIS, PC A02/MF A01. Order Number DE84002949.

A description of the process for producing defense nuclear materials at SRP is required for the Environmental Impact Statement on the restart of L Reactor. This memorandum briefly presents the facilities and generally reviews the processes directly associated with the production of plutonium and tritium. L Reactor has been on standby since 1968 and is currently undergoing renovation for a scheduled restart in October 1983. The reactor operated from 1954 to 1968 when decreasing demand for defense nuclear materials caused it to be placed in standby status. The operation of L Reactor is required to help attain the established levels of defense nuclear materials. Upon restart, L Reactor will operate in the same manner as the reactors currently in use and similar to the methods used previously.

4698 **(DPST—83-640) Increased N Reactor power.** Macafee, I.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 29 Jun 1983. Contract AC09-76SR00001. 4p. NTIS, PC A02/MF A01. Order Number DE84003026.

A partial alternative to restart of L Reactor to help attain the levls of defense nuclear materials established by the President would be to increase the thermal power of the Hanford N Reactor. An estimated 14% power increase can be achieved by increasing the reactor coolant flow slightly more than 14%. The reactor power increase would result in a 14% production increase and would increase component throughput accordingly.

4699 **(DPST—83-643) Alternatives to L startup: new production reactor.** Hostetler, D.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 29 Jun 1983. Contract AC09-76SR00001. 34p. NTIS, PC A03/MF A01. Order Number DE84002951.

An alternative to renewed operation of L Reactor for increased production of nuclear materials would be the construction and operation of a New Production Reactor (NPR). This report describes a conceptual design for a low temperature heavy water reactor with no electricity generation (LTHWR-NE) to be built as a new production reactor at the Savannah River Plant (SRP). The reactor design is based on the proven SRP reactor design with enhancements and state-of-the-art equipment. Aluminum cladding temperatures would be the same as with current operations. The power and productivity of the new reactor would be greater than L Reactor by about 30%. However, the estimated time from authorization to startup is 10 years. Thus an NPR could not contribute to material production until late 1993 at the earliest.

4700 **(DPST—83-667) Restart of Hanford K Reactor as alternative to restart of L-reactor at SRP.** Gould, T.H. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 13 Jul 1983. Contract AC09-76SR00001. 4p. NTIS, PC A02/MF A01. Order Number DE84002950.

As part of the decision process and environmental review associated with the restart of L-Reactor, possible alternative actions to provide the needed additional capacity for defense nuclear materials are being reviewed and compared with the proposed action, resumption of L-Reactor operation at the Savannah River Plant (SRP) by 1984. One such alternative would be to restart one of the retired K Reactors, KE or KW, at the Hanford Site. This report addresses the viability of this option in relation to the proposed action. Restarting one of the Hanford K-Reactors is not a viable alternative to resuming operation of L-Reactor at SRP. The two K-Reactors have been officially retired, are being dismantled, and are scheduled for decontamination and decommissioning. Upgrading one of the K-Reactors for resumed operation would take at least five years and would cost two to three times more than the renovation of L-Reactor, which is almost completed.

4701 **(DPST—83-714) L-Reactor 186-basin cleaning alternatives.** Turcotte, M.D.S. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 15 Sep 1983. Contract AC09-76SR00001. 5p. NTIS, PC A02/MF A01. Order Number DE84003028.

Operation of L Reactor will necessitate annual cleaning of the L Area 186 basins. Alternatives are presented for sediment discharge due to 186-basin cleaning activities as a basis for choosing the optimal cleaning method. Current cleaning activities (i.e. removal of accumulated sediments) for the P, C and K-Area 186 basins result in suspended solids concentrations in the effluent waters above the NPDES limits, requiring an exemption from the NPDES permit for these short-term releases. The objective of mitigating the 186-basin cleaning activities is to decrease the suspended solids concentrations to within permit limits while continuing satisfactory operation of the basins.

4702 **(UNI-SA—116) A new technique for measuring metal surface properties at the Rayleigh critical angle.** Richardson, R.L. (UNC Nuclear Industries, Inc., Richland, WA (USA)). 19 Oct 1983. Contract AC06-76RL01857. 5p. (CONF-8310187—1). NTIS, PC A02/MF A01. Order Number DE84001770.

From IEEE ultrasonics symposium; Atlanta, GA, USA (31 Oct 1983).

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Cracks in reactor materials are enlarged through stress and thermal cycling. The early detection of micro-cracks, residual stress or other surface anomalies can lead to improved reactor surveillance. The development of an early detection tool is described through the frequency response of a plane water-metal interface ensonified at the Rayleigh critical angle. The character of the residual response demonstrates the frequency of zero reflection for a variety of water-metal interfaces. This technique can be used as a sensitive indicator of surface anomalies found on reactor piping or fuel elements. Furthermore, the technique lends itself to a rapid method for material identification.

4703 **(URS/JAB—8147) Seismic evaluation by comparative analysis of the confinement heat removal, process water, and modified cross-tie header piping systems in reactor building 105-L, Savannah River Plant.** Wong, P.W. (URS/John A. Blume and Associates, Engineers, San Francisco, CA (USA)). Sep 1982. Contract AC09-76SR00001. 26p. NTIS, PC A03/MF A01. Order Number DE84003033.

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This report presents the results of the seismic evaluation of three piping systems located in Reactor Building 105-L at the Savannah River Plant near Aiken, South Carolina. The analysis was performed for E.I. du Pont de Nemours & Company (Du Pont) for the seismic qualification of the piping systems, according to the 1967 Housner criteria, and to recommend actions, which should be taken by Du Pont, to ensure the complete seismic adequacy of these systems. The following systems were analyzed: confinement heat removal system (CHRS); process water system (PWS); and modified cross-tie header system (CTHS).

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REFER ALSO TO CITATION(S) 4458, 4620, 4621, 4622, 4626, 4659, 4694, 4809, 4810, 4811, 4812, 4815

4704 **(BNL-NUREG—33611) Risk evaluation of the alternate-3A modification to the ATWS prevention/mitigation system in a BWR-4, Mark-II power plant.** Papazoglou, I.A.; Karol, R.; Shiu, K.; Bari, R.A. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 7p. (CONF-830816—37). NTIS, PC A02/MF A01 - GPO. Order Number DE84000620.

From International meeting on light-water reactor severe accident evaluation; Cambridge, MA, USA (28 Aug 1983).

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Purpose of this paper is to present a risk evaluation of the ATWS Alternate 3A modification (ATWS-3A) proposed by NRC staff in NUREG-0460 to the ATWS prevention/mitigation system in a BWR nuclear power plant. The evaluation is done relative to three risk indices: the frequency of core damage, the expected early fatalities, and the expected latent fatalities.

4705 **(BNL-NUREG—33833) Analysis of BWR/Mark III drywell failure during degraded core accidents.** Yang, J.W. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 5p. (CONF-831047—112). NTIS, PC A02/MF A01 - GPO. Order Number DE84003806.

From American Nuclear Society winter meeting; San Francisco, CA, USA (30 Oct 1983).

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The potential for a hydrogen detonation due to the accumulation of a large amount of hydrogen in the drywell region of a BWR Mark III containment is analyzed. Loss of integrity of the drywell wall causes a complete bypass of the suppression pool and leads to pressurization of the containment building. However, the predicted peak containment pressure does not exceed the estimates of containment failure pressure.

4706 **(CONF-820619—3) 1982 engineering conference on reliability for the electrical power industry.** Campbell, D.J.; Arendt, J.S.; Battle, R.E.; Baranowsky, P.W. (JBF Associates, Knoxville, TN (USA); Oak Ridge National Lab., TN (USA); Nuclear Regulatory Commission, Washington, DC (USA)). 1982. Contract W-7405-ENG-26. 8p. NTIS, PC A02. Order Number DE83015508.

From 9. annual engineering conference on reliability; Hershey, PA, USA (16 Jun 1982).

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Emergency onsite ac power systems at nuclear power plants are a major concern in plant risk assessments because of the relatively large frequency of loss of offsite power and the dependence of most other safety systems on ac power. Detailed reviews of onsite ac power system designs and reviews of experience with diesel generators at US nuclear power plants form the basis of system reliability analyses that show significant improvements in reliability can be obtained at moderate cost for some plants. Onsite ac power system modifications analyzed include procedural modifications, minor equipment modifications and major equipment additions. Relative costs of various modifications are compared with associated system reliability improvements.

4707 **(CONF-830816—42) Overview of BWR Severe Accident Sequence Analyses at Oak Ridge National Laboratory.** Hodge, S.A. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01. Order Number DE84000645.

From International meeting on light-water reactor severe accident evaluation; Cambridge, MA, USA (28 Aug 1983).

Since its inception in October 1980, the Severe Accident Sequence Analysis (SASA) program at Oak Ridge National Laboratory (ORNL) has completed four studies including Station Blackout, Scram Discharge Volume Break, Loss of Decay Heat Removal, and Loss of Injection accident sequences for the Browns Ferry Nuclear Plant. The accident analyses incorporated in a SASA study provide much greater detail than that practically achievable in a Probabilistic Risk Assessment (PRA). When applied to the candidate dominant accident sequences identified by a PRA, the detailed SASA results determine if factors neglected by the PRA would have a significant effect on the order of dominant sequences. Ongoing SASA work at ORNL involves the analysis of Anticipated Transients Without Scram (ATWS) sequences for Browns Ferry.

4708 **(DOE/SF/01112—T3) Final report of the APRICOT Program and results of Phase 3.** (Science Applications, Inc., San Leandro, CA (USA)). Sep 1982. Contract AC03-76SF01112. 16p. NTIS, PC A02/MF A01. Order Number DE83016546.

APRICOT (Analysis of PRImary COntainment Transients) was a cooperative activity for comparison and benchmarking of computational methods used to analyze LMFBR (Liquid Metal Fast Breeder Reactor) structural response to pressure loads from HCDA's (Hypothetical Core Disruptive Accidents). The participants were LMFBR project groups from Europe, Japan and the United States. Independent experts reviewed the calculations for the purpose of comparing computational results and methods of solution. Phase 3 involved a series of simple calculations of structural response and fluid-structure interactions under elastic and elastic-plastic conditions. The results were generally in reasonable agreement although there were a few anomalies. The APRICOT program has provided significant code validation data to enhance confidence in numerical simulations of HCDA's. It has also demonstrated the value of this type of benchmark activity.

4709 **(DPSP—70-1457) Source rod failure - K Area.** Olliff, W.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). 1970. Contract AC09-76SR00001. 49p. NTIS MF A01. Order Number DE84003029.

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Charts are presented that elaborate on the source rod failure in the K Reactor and the subsequent cleanup and decontamination measures required.

4710 **(DPST—81-481) Analysis of water diversion paths to by-pass clay pipe.** Olson, H.P. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 5 Jun 1981. Contract AC09-76SR00001. 19p. NTIS, PC A02/MF A01. Order Number DE84003685.

The vitreous clay pipes that channel spilled water from the production reactor buildings (105-Bldg.) to the water confinement tanks (803 tank) and the earthen retention basins have damaged sections and repairs are in progress. Diversion paths are being considered to control the destination of water in the event a clay pipe should fail to carry water to the tank and basin. This memorandum discusses the relative risks to various diversion paths. 4 references, 5 figures, 8 tables.

4711 **(DPST—83-717(Del.)) Risk estimates for SRP production reactor operation.** Church, J.P. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 26 Aug 1983. Contract AC09-76SR00001. 38p. NTIS, PC A03/MF A01. Order Number DE84002820.

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Safety studies, either completed or underway, for SRP reactors have postulated a variety of accident sequences that could damage the reactor core. Occurrence frequencies have been estimated for some of the postulated sequences. The probable consequences of core damage have been estimated in terms of dose to an individual at the plant boundary. The present study combines these two factors, i.e., occurrence frequency and consequence to obtain a preliminary estimate of the risk of SRP reactor operation.

4712 **(EGG-M—05583) Balance of plant modeling in TRAC-BD1/MOD1.** Weaver, W.L.; Giles, M.M.; Mohr, C.M. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 9p. (CONF-830901—19). NTIS, PC A02/MF A01. Order Number DE84002157.

From Anticipated and abnormal plant transients in light water reactors conference; Jackson, WY, USA (26 Sep 1983).

The mission of the TRAC-BD1/MOD1 code is to provide a best-estimate analysis capability for Boiling Water Reactor systems and related experimental facilities for the full range of accidents from large and small break Loss-of-Coolant accidents to operational transients including anticipated transients without scram (ATWS), for which point reactor kinetics is adequate (as a first approximation). Recent model developments allow a complete reactor system including the containment and the balance of plant to be modeled. This paper describes the balance of plant models and presents the results of a simulation of a loss-of-feedwater heater transients which was used to assess the performance of the balance of plant models.

4713 **(EGG-M—08383) Iodine and cesium behavior during the first PBF Severe Fuel Damage Test.** Osetek, D.J.; Vinjamuri, K.; Kudera, D.E.; Hobbins, R.R. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 6p. (CONF-830816—40). NTIS, PC A02/MF A01. Order Number DE84000885.

From International meeting on light-water reactor severe accident evaluation; Cambridge, MA, USA (28 Aug 1983).

The results of iodine and cesium measurements made during the Severe Fuel Damage Scoping Test at the Power Burst Facility are presented. On-line gamma spectroscopy and grab samples of the test effluent were used to measure the isotopic release histories at four locations in the effluent sampling system. Total release fractions, release rates, analysis of filter debris, and sample line deposition characteristics are discussed. Iodine and cesium release rate constants measured during the experiment are compared with published NRC data.

4714 **(EGG-M—12883) RELAP5 analyses of overcooling transients in a pressurized water reactor.** Bolander, M.A.; Fletcher, C.D.; Ogden, D.M.; Stitt, B.D.; Waterman, M.E. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 13p. (CONF-830901—10). NTIS, PC A02/MF A01. Order Number DE84000803.

From Anticipated and abnormal plant transients in light water reactors conference; Jackson, WY, USA (26 Sep 1983).

In support of the Pressurized Thermal Shock Integration Study sponsored by the United States Nuclear Regulatory Commission, the Idaho National Engineering Laboratory has performed analyses of overcooling transients using the RELAP5/MOD1.5 computer code. These analyses were performed for Oconee Plants 1 and 3, which are pressurized water reactors of Babcock and Wilcox lowered-loop design. Results of the RELAP5 analyses are presented, including a comparison with plant data. The capabilities and limitations of the RELAP5/MOD1.5 computer code in analyzing integral plant transients are examined. These analyses require detailed thermal-hydraulic and control system computer models.

4715 **(EGG-M—13883) Interactive operator guideline evaluation using RELAP5.** Beelman, R.J.; Curtis, J.N. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 8p. (CONF-831047—102). NTIS, PC A02/MF A01. Order Number DE84002223.

From American Nuclear Society winter meeting; San Francisco, CA, USA (30 Oct 1983).

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A capability has been developed at the Idaho National Engineering Laboratory to interactively execute the RELAP5 thermal-hydraulic systems code to evaluate safety related concerns arising from the implementation of operator guidelines. This capability also allows simultaneous on-line analysis of the resulting calculation by way of color-graphic display techniques. An analyst is able to interactively implement operator guideline procedures during a reactor plant transient simulation, as the calculation proceeds, while observing the overall effects of these actions by way of a CRT color-graphic display presentation. Properly applied, the tool will reduce analysis costs, enhance calculational accuracy and consistency, ensure proper internal application of code constitutive models, enhance understanding of the interrelationship among complex thermal-hydraulic phenomena, and expedite resolution of safety related concerns.

4716 **(EGG-M—14283) Monitoring reactor-vessel liquid level with a vertical string of SPNDs.** Adams, J.P.; Berta, V.T. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 9p. (CONF-831047—106). NTIS, PC A02/MF A01. Order Number DE84002222.

From American Nuclear Society winter meeting; San Francisco, CA, USA (30 Oct 1983).

Changes in in-core self-powered neutron detector signals, recorded during a nuclear loss-of-coolant accident (LOCA) simulation, have been correlated with liquid level changes which occurred during the core uncovery and recovery events. The correlations indicate that these detectors can be used to monitor reactor vessel liquid level during a LOCA. A display and alarm system using these detectors to provide reactor operators with an indication of a core uncovery and subsequent thermal excursion and with a means to measure the effectiveness of LOCA recovery procedures is described.

4717 **(EGG-M—14583) SCDAP replication of MARCH hydrogen calculations.** Chambers, R. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 5p. (CONF-830816—38). NTIS, PC A02/MF A01. Order Number DE84000897.

From International meeting on light-water reactor severe accident evaluation; Cambridge, MA, USA (28 Aug 1983).

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The two codes, MARCH and SCDAP, were used to calculate the rate of hydrogen production during various reactor accidents involving degraded core cooling. A brief description of the MARCH code is given, followed by a description of SCDAP.

4718 **(EGG-M—16183) RELAP5/MOD2: for PWR transient analysis.** Ransom, V.H. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 22p. (CONF-830932—6). NTIS, PC A02/MF A01. Order Number DE84000801.

From International conference on numerical methods in nuclear engineering; Montreal, Canada (6 Sep 1983).

RELAP5 is a light-water-reactor system transient-simulation code for use in nuclear-plant safety analysis. Development of a new version, RELAP5/MOD2, has been completed and it will be released to the United States Nuclear Regulatory Commission during September of 1983. The new and improved modeling capability of RELAP5/MOD2 is described and some developmental assessment results are presented. The future plans for extension to severe accident modeling are briefly discussed.

4719 **(EGG-M—16282) HDR flood-water storage-tank modal vibration tests.** Gorman, V.W.; Thinnes, G.L. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 17p. (CONF-830805—55). NTIS, PC A02/MF A01. Order Number DE84001002.

From 7. international conference on structural mechanics in reactor technology; Chicago, IL, USA (22 Aug 1983).

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Modal vibration tests were conducted by EG & G Idaho on two vessels located at West Germany's Heissdampfreaktor (HDR) facility which is 25 kilometers east of Frankfurt. The tests were performed during May and June 1982 for the US Nuclear Regulatory Commission (NRC) as part of their cooperative effort with Kernforschungszentrum Karlsruhe (KfK) of West Germany. The primary purpose for performing this task was to determine modal properties (frequencies, mode shapes and associated damping ratios) in order to eventually provide guidelines for standards development by the NRC in modeling similar vessels. One of the vessels tested was a flood water storage tank (FWST) for empty, half full and full water conditions. The FWST was excited randomly with an electromagnetic shaker and by impulsive hammer blows. Excitation or input forces together with measured vessel responses were processed by a digital modal analyzer and stored on magnetic disks for subsequent evaluation.

4720 **(EGG-M—16583) Evaluation of past nuclear events and CORRAL-2 analyses of fission-product transport at TMI-2 and PRTR.** Kudera, D.E.; Vinjamuri, K.; Croucher, D.W. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 7p. (CONF-830816—43). NTIS, PC A02/MF A01. Order Number DE84000889.

From International meeting on light-water reactor severe accident evaluation; Cambridge, MA, USA (28 Aug 1983).

Past accidents and destructive tests may provide information and data for the assessment of current fission product behavior computer codes. The purpose of this paper is to highlight a review of past nuclear events and to present the results of calculations of fission product transport during the Three Mile Island Unit 2 (TMI-2) and the Plutonium Recycle Test Reactor (PRTR) accidents using the CORRAL-2 computer code. Various past nuclear events, the state of the art of various computer codes that have been reviewed, CORRAL-2 calculations performed for the TMI-2 and the PRTR accidents, and conclusions reached from this work are summarized.

4721 **(EGG-M—20083) Pressurized-water-reactor station blackout.** Dobbe, C.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 7p. (CONF-8310143—39). NTIS, PC A02/MF A01. Order Number DE84002205.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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The purpose of the Severe Accident Sequence Analysis (SASA) Program was to investigate accident scenarios beyond the design basis. The primary objective of SASA was to analyze nuclear plant transients that could lead to partial or total core melt and evaluate potential mitigating actions. The following summarizes the pressurized water reactor (PWR) SASA effort at the Idaho National Engineering Laboratory (INEL). The INEL is presently evaluating Unresolved Safety Issue A-44 - Station Blackout from initiation of the transient to core uncovery. The balance of the analysis from core uncovery until fission product release is being performed at Sandia National Laboratory (SNL). The current analyses involve the Bellefonte Nuclear Steam Supply System (NSSS), a Babcock and Wilcox (B and W) 205 Fuel Assembly (205-FA) raised loop design to be operated by the Tennessee Valley Authority (TVA).

4722 **(EGG-M—20583) Conclusions from the independent assessment of TRAC-BD1/Version 12.** Wilson, G.E. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 13p. (CONF-8310143—43). NTIS, PC A02/MF A01. Order Number DE84002217.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

The boiling water reactor (BWR) Transient Reactor Analysis code (TRAC) is an advanced best-estimate computer code originally developed for the thermal-hydraulic analysis of BWR loss-of-coolant accidents (LOCAs). Recent and planned additions to the code also offer capabilities that are considered useful in the simulations of other severe accidents. The developmental work is being conducted at the Idaho National Engineering Laboratory (INEL) by EG and G Idaho, Inc. for the United States Nuclear Regulatory Commission (NRC). The code is structured to address single-and two-phase, nonequilibrium, multidimensional hydraulic conditions. An intermediate version of the code (TRAC-BD1/Version 12) underwent a limited release to interested agencies in April 1982. Then, from April 1982 to May 1983, a series of nine independent assessment studies, consisting of 14 test simulations, was performed at the INEL by EG and G Idaho. The major conclusions from these studies relate to code technology strengths and deficiencies, recommended modeling practice, and run statistics.

4723 **(EGG-M—20683) Damping studies.** Ware, A.G. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 10p. (CONF-8310143—34). NTIS, PC A02/MF A01. Order Number DE84002216.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

Two series of vibration tests on 3- and 8-inch diameter carbon steel pipes with different support configurations were conducted to determine the damping characteristics of each. The purposes of the tests were to achieve a better understanding of the physical nature of piping system damping, to determine typical values of the various supports, and to supply data for use in the US Nuclear Regulatory Commission (NRC) and Pressure Vessel Research Committee of the Welding Research Council pipe damping programs. The final goal of these programs is to ascertain whether the current NRC guidelines for piping system damping values can be increased, thereby requiring less seismic supports and making the systems less susceptible to thermal stress failure, less costly, and more reliable.

4724 **(EGG-M—20783) RELAP5/MOD2.** Ransom, V.H. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 12p. (CONF-8310143—36). NTIS, PC A02/MF A01. Order Number DE84002214.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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RELAP5/MOD2 is a pressurized water reactor (PWR) system transient analysis code that has been designed for use in the US Nuclear Regulatory Commission (USNRC) Safety Research and Regulatory Programs. The code is an extension of the RELAP5/MOD1 capability to include simulation of PWR transients up to the point of fuel damage. For analysis of transients involving fuel damage, RELAP5 is being coupled with the SCDAP code, which will permit analysis up to the point of vessel melt through. The improved capability of RELAP5/MOD2 compared to the earlier version is a result of continued improvement of the hydrodynamic models, added user convenience features, and addition of new component models. To a large extent, the new capability has been obtained through logical extension of the RELAP5/MOD1 modeling. As a result, the basic code structure is the same and system model input decks developed for RELAP5/MOD1 are compatible with the RELAP5/MOD2 input requirements, with minor exceptions.

4725 **(EGG-M—20883) RELAP5 analyses and support of Oconee-1 PTS studies.** Charlton, T.R. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 9p. (CONF-8310143—44). NTIS, PC A02/MF A01. Order Number DE84002164.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

The integrity of a reactor vessel during a severe overcooling transient with primary system pressurization is a current safety concern and has been identified as an Unresolved Safety Issue(USI) A-49 by the US Nuclear Regulatory Commission (NRC). Resolution of USI A-49, denoted as Pressurized Thermal Shock (PTS), is being examined by the US NRC sponsored PTS integration study. In support of this study, the Idaho National Engineering Laboratory (INEL) has performed RELAP5/MOD1.5 thermal-hydraulic analyses of selected overcooling transients. These transient analyses were performed for the Oconee-1 pressurized water reactor (PWR), which is Babcock and Wilcox designed nuclear steam supply system.

4726 **(EGG-M—21283) Nuclear plant analyzer development at INEL.** Laats, E.T.; Russell, K.D.; Stewart, H.D. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 9p. (CONF-8310143—41). NTIS, PC A02/MF A01. Order Number DE84002209.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

The Office of Nuclear Regulatory Research of the US Nuclear Regulatory Commission (NRC) has sponsored development of a software-hardware system called the Nuclear Plant Analyzer (NPA). This paper describes the status of the NPA project at the INEL after one year of development. When completed, the NPA will be an integrated network of analytical tools for performing reactor plant analyses. Development of the NPA in FY-1983 progressed along two parallel pathways; namely, conceptual planning and software development. Regarding NPA planning, and extensive effort was conducted to define the function requirements of the NPA, conceptual design, and hardware needs. Regarding software development conducted in FY-1983, all development was aimed

toward demonstrating the basic concept and feasibility of the NPA. Nearly all software was developed and resides on the INEL twin Control Data Corporation 176 mainframe computers.

4727 **(EGG-M—21483) SCDAP severe core-damage studies: BWR ATWS and PWR station blackout.** Laats, E.T.; Chambers, R.; Driskell, W.E. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 8p. (CONF-8310143—33). NTIS, PC A02/MF A01. Order Number DE84002113.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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The Severe Accident Sequence Analysis (SASA) Program, sponsored by the US Nuclear Regulatory Commission (NRC), is addressing a number of accident scenarios that potentially pose a health hazard to the public. Two of the scenarios being analyzed in detail at the Idaho National Engineering Laboratory (INEL) are the station blackout at the Bellefonte nuclear plant and the anticipated transient without scram (ATWS) at the Browns Ferry-1 plant. The INEL analyses of the station blackout and ATWS have been divided into four parts, which represent the sequence being followed in this study. First, the evaluation of long term irradiation effects prior to the station blackout or ATWS was conducted using the FRAPCON-2 fuel rod behavior code; second, the reactor primary and secondary coolant system behavior is being analyzed with the RELAP5 code; third, the degradation of the core is being analyzed with the SCDAP code; and finally, the containment building response is being analyzed with the CONTEMPT code. This paper addresses only the SCDAP/MODO degraded core analyses for both the station blackout and ATWS scenarios.

4728 **(EGG-M—21583) INEL BWR severe accidnet ATWS study.** Jouse, W.C. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 7p. (CONF-8310143—40). NTIS, PC A02/MF A01. Order Number DE84002208.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

The subject of this study is a postulate Anticipated Transient Without Scram (ATWS) at unit one of the Browns Ferry nuclear plant, a boiling water reactor (BWR). The development work is being conducted at the Idaho National Engineering Laboratory (INEL) for the U.S. Nuclear Regulatory Commission (NRC). It has long been recognized that the dominant ATWS transient in BWRs is the main steamline isolation valve (MSIV) closure pressurization type of event. The analytic tool used in this study is RELAP5/MOD1.6. This version of RELAP5 has the capability to simulate BWR plants in that several special process models, such as a jet pump momentum mixer model, have been installed.

4729 **(EGG-M—22183) Semiscale steam-generator tube-rupture test results.** Dimenna, R.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 10p. (CONF-8310143—37). NTIS, PC A02/MF A01. Order Number DE84002204.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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The Semiscale Program and Test facility are located at the Idaho National Engineering Laboratory, and operated by EG and G Idaho, Inc., for the US Department of Energy. The system is a small-scale model of the primary coolant system of a pressurized water reactor (PWR) nuclear generating plant. An experimental program designed to provide data from steam generator tube rupture is presently being conducted in the Semiscale Mod-2B System in support of programs sponsored by the US Nuclear Regulatory Commission Office of Nuclear Regulatory Research. The test series will provide computer code verification data for a spectrum of tube rupture events including various break sizes (modeling number of tubes ruptured) and various operator safety actions in response to the rupture. The test series will also be used to characterize accident signatures and plant response to typical emergency recovery procedures.

4730 **(EGG-M—22283) Semiscale loss-of-power test results.** Martinell, J.S. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 12p. (CONF-8310143—48). NTIS, PC A02/MF A01. Order Number DE84002211.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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The Semiscale Program and Test facility are located at the Idaho National Engineering Laboratory, and operated by EG & G Idaho, Incorporated for the US Department of Energy. The system is a small-scale model of the primary coolant system of a pressurized water reactor (PWR) nuclear generating plant. It incorporates the major components of a PWR and is capable of attaining typical operating pressures and temperatures. An experimental program designed to provide data from loss-of-power transients was conducted in Semiscale in FY-83 in support of programs sponsored by the US Nuclear Regulatory Commission, Office of Nuclear Regulatory Research. This Semiscale program provides information relative to resolution of the station blackout safety issue through validation of thermal-hydraulic computer codes used in accident sequence analyses. Description of the experimental objectives, scenarios, and results is presented.

4731 **(EGG-M—22583) CONTEMPT/LT-028 Browns Ferry studies of an anticipated transient without scram.** Holcomb, E.E. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 12p. (CONF-8310143—42). NTIS, PC A02/MF A01. Order Number DE84002207.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

The Browns Ferry Nuclear Plant containment response during the first 30 min of an anticipated transient without scram (ATWS) is the subject of this paper. Three cases, each initiated by a main steam isolation valve closure, are presented: the ATWS is mitigated by operator actions in the spirit of the General Electric Emergency Procedure Guidelines; the ATWS is managed by the plant automatic control systems; and the ATWS proceeds as in first case except that the drywell coolers are unavailable. Success of the standby liquid control system is assumed in the last two transients.

4732 **(GAO/RCED—83-158) Response to specific questions on the Indian Point probabilistic safety study.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 24 May 1983. 58p. General Accounting Office, Document Handling and Information Service Facility, P.O. Box 6015, Gaithersburg, MD 20760.

This report describes and summarizes how probabilistic risk assessment (PRA) is applied to nuclear powerplants, the methodology and results of a PRA on the Indian Point plants near New York City, and peer review comments on that study. PRAs attempt to examine complex systems, such as nuclear powerplants, and identify their potential safety, environmental, and economic risks. GAO found that while the Indian Point PRA may represent the state of the art in risk assessment, it suffers from the same limitations as all PRAs: uncertainties and inconsistencies in data, models, assumptions, and methods. Although the study identified the dominant contributors to risk, it did not identify the precise level of risk from operating the Indian Point nuclear powerplants.

4733 **(INIS-mf—8404) National safety standards: KTA - safety standards as an example.** Schwarzer, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 26p. (CONF-8109220—8). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703274.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The question, which is often asked, namely how many standards and how much time is needed to prepare a complete system of nuclear safety standards, has no answer in terms of numbers or years. The number of standards necessarily depends not only on the contents of an individual average standard. It also depends on the need to go increasingly into details and, to a large extent, on the problems which are identified and resolved during the continuous

development of a technology. This is also means, that there is not time limit for the development of such standards, except the time when a technology becomes obsolete. In the same way, as safety in a technology never becomes an issue which is resolved once and for all, but is and must be a continuous and coordinated effort, the codification of safety requirements will always be a continuing task, lasting as long as experiences are made and can be used to improve the safety of the technology.

4734 **(INIS-mf—8419) Fire protection in nuclear power plants.** Wright, H.A. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 5p. (CONF-8109220—9). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83703275.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

This lecture describes briefly the chronological order of events which may arise for a very serious emergency situation in a nuclear power plant for which preparations should be made even though the situation has an extremely low probability of happening. The planning and preparedness required are expected to cope with a whole spectrum of emergency situations, from minor accidents to serious plant failures which also lead to releases of significant quantities of radioactive material beyond the site boundary. Fire protection aspects will be briefly covered, and some guidance will be provided on exercises to ensure the plans are feasible and the appropriate personnel and facilities are in a satisfactory state of preparedness.

4735 **(INIS-mf—8423) Management for nuclear power plants for safe operation.** Kueffer, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 16p. (CONF-8109220—10). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703276.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

This lecture covers management aspects which have an immediate bearing on safety and identifies the objectives and tasks of management which are required for safe operation of a nuclear power plant and is based on the Codes of Practice and Safety Guides of the IAEA as well as arrangements in use at the Swiss Nuclear Power Station Beznau.

4736 **(INIS-mf—8424) On-site emergency planning.** Kueffer, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 16p. (CONF-8109220—11). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703277.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

This lecture covers the Emergency Planning of the Operating Organization and does not describe the functions and responsibilities of the Regulatory Body and public authorities. The lecture is based on the Codes of Practice and Safety Guides of the International Atomic Energy Agency (IAEA) and arrangements as in use in the Swiss Nuclear Power Station Beznau. (orig.).

4737 **(INIS-mf—8429) Plant design and layout of the different buildings with respect to safety, operational and maintenance requirements. Aspects of civil engineering.** Linder, C. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 7p. (CONF-8109220—12). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703278.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

Design and layout of the buildings of a nuclear power plant are governed by the safety requirements regarding nearby population as called for by government regulations as well as by operational and maintenance requirements called for by the power utilities in order to assure smooth operation and easy service conditions. The lecture will focus on the different functional circumstances to be considered, their relative importance, criteria to be applied, pertinent regulations etc. and also give examples on the solutions to the above requirements. Main topics to be covered will be those circumstances that impose the highest demands on the civil engineering layout and design: airplane impact, earthquake, loss of coolant accident, pipe whipping, fuel cask transfer, annual overhaul, leak detection etc.

4738 **(INIS-mf—8430) Church and nuclear power.** Stoll, W.; Self, K.P. (Rabanus Maurus-Akademie, Frankfurt am Main (Germany, F.R.)). Sep 1982. 52p. (In German). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703279.

This position paper is the result of talks conducted by natural scientists and engineers with ethical specialists and theologists in 1980/81. To cope with the difficulty of the authenticity of ecclesiastical statements, the report was worked out as an independent paper giving not only a negative response to past ecclesiastical pronouncements but taking a stand regarding nuclear energy from the point of view of the natural sciences respectively technology. As it was not possible to reach agreement in all points, the partners in the talks consider this position paper to be a statement on nuclear energy by natural scientists and engineers grown from the discussions with ethical specialists and theologists. The partners in the discussions agree that this can only be a first step.

4739 **(INIS-mf—8435) Training in health physics (in general).** Staeblein, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 7p. (CONF-8109220—17). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703290.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

Nuclear power needs radiation protection. Knowledge and practical training therefore must be acquired by different groups of persons, i.e. responsible persons, radiation protectors, occupationally exposed persons and residents. The acquisition and qualification of the professional knowledge in radiation protection (in Germany, for example) is regulated by law and ordinances. The professional knowledge is offered by schools, academies and employers. Personnel requirements and plans of instruction shall be dealt with.

4740 **(INIS-mf—8436) Special points of health physics in connection with the operation of a nuclear power plant.** Samuel, T. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 25p. (CONF-8109220—13). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703280.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

The paper covers the origin of the radioactivity in nuclear power plants, the type of sources (open or sealed) encountered, and their methods of measurement. It covers the problem of personnel dosimetry, including contamination and incorporation, and the administrative methods used to avoid these. It outlines a general work philosophy, as developed in an actual power plant.

4741 **(INIS-mf—8444) PWR plant model for the analysis of large amplitude transients.** Frisch, W.; Schmidt, K.D. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 20p. (CONF-8009308—48). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703283.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

The PWR transient code ALMOD has been developed to cover a wide range of transient and accident simulation in safety analysis, comprising failure of safety system components (e.g. analysis of anticipated transients without scram=ATWS). Because of the large amplitudes to be expected during the transients, simplified models such as linearized models, used in control system analysis, are not applicable here. As the transients have to be analyzed over minutes, feedback from the entire coolant system becomes effective, thus requiring the simulation of core and both primary and secondary coolant system. Because of the long duration of the transients special emphasis has been put on computational speed. Key variables of interest in transient analysis are fuel and cladding temperature as well as primary and secondary system pressure. Extreme plant conditions such as two phase flow in the primary coolant

system, filling of the pressurizer with water etc. have to be simulated with sufficient accuracy.

4742 **(INIS-mf—8449) Postulated accidents.** Ullrich, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 46p. (CONF-8009308—50). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703285.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

This lecture on 'Postulated Accidents' is the first of a series of lectures on the dynamic and transient behaviour of nuclear power plants, especially pressurized water reactors. The main points covered will be: Reactivity Accidents, Transients (Intact Loop) and Loss of Cooland Accidents (LOCA) including small leak. This lecture will discuss the accident analysis in general, the definition of the various operational phases, the accident classification, and, as an example, an accident sequence analysis on the basis of 'Postulated Accidents'.

4743 **(INIS-mf—8450) Nuclear power plant safety in Brazil.** Lederman, L. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 20p. (CONF-8009308—51). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703286.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

The Code of Practice for the Safe Operation of Nuclear Power Plants states that: 'In discharging its responsibility for public health and safety, the government should ensure that the operational safety of a nuclear reactor is subject to surveillance by a regulatory body independent of the operating organization'. In Brazil this task is being carried out by the Comissao Nacional de Energia Nuclear in accordance with the best international practice.

4744 **(INIS-mf—8455) Work session on the SAR. Pt. 3. Drawings.** Burkart, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1980. 13p. (CONF-8009308—32-Pt.3). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703287.

From IAEA interregional training course on safety analysis; Karlsruhe, F.R. Germany (3 Sep 1980).

This paper contains the drawings and diagrams of the contribution of K. Burkart 'Work Session on the SAR' to the IAEA Interregional Course held in Sept/Oct. 1980 at the Kernforschungszentrum Karlsruhe.

4745 **(INIS-mf—8467) Workshop on safety analysis reports and licensing procedures. Pt. 1 B.** Hunger, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1981. 23p. (CONF-8109220—16-Pt.1B). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703288.

From IAEA interregional training course on nuclear power plant operational safety; Karlsruhe, F.R. Germany (7 Sep 1981).

In the present paper two main topics of PWR safety are dealt with: The decay heat removal following loss of coolant accidents and the ECCS for a two-loop NSSS with once-through steam generators.

4746 **(NUREG—0606-Vol.5-No.3) Unresolved safety issues summary: Aqua Book. Volume 5, No. 3.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Resource Management). 19 Aug 1983. 93p. NTIS, PC A05/MF A01 - GPO. Order Number DE84900271.

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The unresolved safety issues summary is designed to provide the management of the Nuclear Regulatory Commission with a quarterly overview of the progress and plans for completion of generic tasks addressing unresolved safety issues reported to Congress pursuant to section 210 of the Energy Reorganization Act of 1974 as amended. The schedules in this book include a milestone at the end of each action plan which represents the initiation of the implementation process both with respect to incorporation of the technical resolution in the NRC official guidance or requirements and also the application of changes to individual operating plants. The schedule for implementation will not normally be included in the task action plan(s) for the resolution of a USI since the nature and extent of the activities necessary to accomplish the implementation cannot normally be reasonably determined prior to the determination of a technical resolution. The progress and status for implementation of unresolved safety issues for which a technical resolution has been completed are reported specifically in a separate table provided in this summary.

4747 **(NUREG/CR—2331-Vol.3-No.1) Safety research programs sponsored by Office of Nuclear Regulatory Research. Quarterly progress report, January 1-March 31, 1983. Volume 3, No. 1.** Bari, R.A.; Cerbone, R.J.; Ginsberg, T.; Greene, G.A.; Guppy, J.G.; Hall, R.E.; Luckas, W.J. Jr.; Reich, M.; Saha, P.; Sastre, C. (Brookhaven National Lab., Upton, NY (USA)). Jun 1983. Contract AC02-76CH00016. 164p. (BNL-NUREG—51454-Vol.3-No.1). NTIS, PC A08/MF A01 - GPO. Order Number DE84003184.

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The projects reported are the following: HTGR Safety Evaluation, SSC Development, Validation and Application, CRBR Balance of Plant Modeling, Thermal-Hydraulic Reactor Safety Experiments, LWR Plant Analyzer Development, LWR Code Assessment and Application; Stress Corrosion Cracking of PWR Steam Generator Tubing, Bolting Failure Analysis, Probability Based Load Combinations for Design of Category I Structures, Mechanical Piping Benchmark Problems, Soil Structure Interaction; Human Error Data for Nuclear Power Plant Safety Related Events, Criteria for Human Engineering Regulatory Guides and Human Factors in Nuclear Power Plant Safeguards.

4748 **(NUREG/CR—2573) BWR Refill-Reflood Program, Task 4.7 - model development: basic models for the BWR version of TRAC.** Andersen, J.G.M.; Chu, K.H.; Shaug, J.C. (General Electric Co., San Jose, CA (USA). Nuclear Fuel and Special Projects Div.). Sep 1983. 115p. (EPRI-NP—2375; GEAP—22051). NTIS, PC A06/MF A01 - GPO $5.00. Order Number DE84900087.

TRAC (Transient Reactor Analysis Code) is a computer code for best estimate analysis of the thermal hydraulic conditions in a reactor system. The constitutive correlations for shear and heat transfer developed for the Boiling Water Reactor (BWR) version of TRAC are described. A universal flow regime map has been developed to tie the regimes for shear and heat transfer into a consistent package. New models in the areas of interfacial shear, interfacial heat transfer and thermal radiation have been introduced. Improvements have also been made to the constitutive correlations and the numerical methods. All the models have been implemented into the GE version TRACB02 and extensively tested against data.

4749 **(NUREG/CR—2574) BWR Refill-Reflood Program, Task 4.7 - model development: TRAC-BWR component models.** Cheung, Y.K.; Parameswaran, V.; Shaug, J.C. (General Electric Co., San Jose, CA (USA). Nuclear Fuel and Special Projects Div.). Sep 1983. 117p. (EPRI-NP—2376; GEAP—22052). NTIS, PC A06/MF A01 - GPO $5.00. Order Number DE84900137.

TRAC (Transient Reactor Analysis Code) is a computer code for best-estimate analysis for the thermal hydraulic conditions in a reactor system. The development and assessment of the BWR component models developed under the Refill/Reflood Program that are necessary to structure a BWR-version of TRAC are described in this report. These component models are the jet pump, steam separator, steam dryer, two-phase level tracking model, and upper-plenum mixing model. These models have been implemented into TRAC-B02. Also a single-channel option has been developed for individual fuel-channel analysis following a system-response calculation.

4750 **(NUREG/CR—2814-Vol.4) Nuclear reactor safety. Vol. 4. Progress report, October 1-December 31, 1982.** Sheheen, N.N.; Stevenson, M.G. (comps.). (Los Alamos National Lab., NM (USA)). Jul 1983. Contract W-7405-ENG-36. 26p. (LA—9740-PR-Vol.4). NTIS, PC A03/MF A01 - GPO. Order Number DE84002614.

Presented are brief overviews compiled by project, along with a bibliography of Technical Notes and publications written during this quarter. The projects include: TRAC development, thermal-hydraulic analysis, TRAC assessment, HTGR structures, upper structures, safety analysis methods, advanced converters, severe accident sequence, and TRAC calculations.

4751 **(NUREG/CR—2987) Identification and analysis of human errors underlying electrical/electronic component related events reported by nuclear power plants licensees.** Speaker, D.M.; Voska, K.J.; Luckas, W.J. Jr. (Brookhaven National Lab., Upton, NY (USA)). Jun 1983. Contract AC02-76CH00016. 69p. (BNL-NUREG—51592). NTIS, PC A04/MF A01 - GPO. Order Number DE84002896.

This report provides a useful and adaptable data base of over 700 human error events associated with the operation, testing, maintenance of instrumentation, control and in-plant electrical power components in licensed nuclear power plants. More than 8000 Licensee Event Report (LER) Abstracts were retrieved from the Department of Energy (DOE)/RECON Data Base, Nuclear Safety Information Center (NSIC) File for certain specific safety related systems. The data developed in this report were obtained by the application of a practical and workable human error identification methodology. The resulting human error data base is several times larger than would have been available based solely on licensee identification of human error. This data base is intended to provide a realistic assessment of the real human error populations obtainable from the LERs.

4752 **(NUREG/CR—3223) BWR Refill-Reflood Program. Final report.** Myers, L.L. (General Electric Co., San Jose, CA (USA). Nuclear Fuel and Special Projects Div.). Sep 1983. 144p. (EPRI-NP—3093; GEAP—30157). NTIS, PC A07/MF A01 - GPO $5.50. Order Number DE84900086.

The BWR Refill-Reflood Program is part of the continuing Loss of Coolant Accident (LOCA) research in the United States which is jointly sponsored by the Nuclear Regulatory Commission, the Electric Power Research Institute, and the General Electric Company. The current program expanded the focus of this research to include full scale experimental evaluations of multidimensional and multichannel effects during system refill. The program has also made major contributions to the BWR version of the Transient Reactor Analysis Code (TRAC) which has been developed cooperatively with the Idaho National Engineering Laboratory (INEL) for application to BWR transients. A summary description of the complete program is provided including the principal findings and main conclusions of the program. The results of the program have shown that multidimensional and parallel channel effects have the potential to significantly improve the system response over that observed in single channel tests.

4753 **(NUREG/CR—3279-Vol.1) Nuclear reactor safety. Progress report, January 1-March 31, 1983. Volume 1.** Sheheen, N.N.; Stevenson, M.G. (comps.). (Los Alamos National Lab., NM (USA)). Sep 1983. Contract W-7405-ENG-36. 33p. (LA—9822-PR). NTIS, PC A03/MF A01 - GPO. Order Number DE84002618.

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The work that is highlighted here represents accomplishments for the period January 1 to March 31, 1983 by the groups at Los Alamos involved in reactor safety research for the Division of Accident Evaluation, Office of Nuclear Regulatory Research of the US Nuclear Regulatory Commission. Presented are brief overviews compiled by project, along with a bibliography of Technical Notes and publications written during this quarter.

4754 **(NUREG/CR—3286) ORNL instrumentation performance for Slab Core Test Facility (SCTF)-Core I Reflood Test Facility.** Hardy, J.E.; Hess, R.A.; Hylton, J.O. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 202p. (ORNL/TM—8762). NTIS, PC A10/MF A01 - GPO. Order Number DE84002408.

Instrumentation was developed for making measurements in experimental refill-reflood test facilities. These unique instrumentation systems were designed to survive the severe environmental conditions that exist during a simulated pressurized water reactor loss-of-coolant accident (LOCA). Measurement of in-vessel fluid phenomena such as two-phase flow velocity and void fraction and film thickness and film velocity are required for better understanding of reactor behavior during LOCAs. The Advanced Instrumentation for Reflood Studies (AIRS) Program fabricated and delivered instrumentation systems and data reduction software algorithms that allowed the above measurements to be made. Data produced by AIRS sensors during three experimental runs in the Japanese Slab Core Test Facility are presented. Although many of the sensors failed before any useful data could be obtained, the remaining probes gave encouraging and useful results. These results are the first of their kind produced during simulated refill-reflood stage of a LOCA near actual thermohydrodynamic conditions.

4755 **(NUREG/CR—3422-Vol.1) Aerosol release and transport program. Quarterly progress report for January-March 1983.** Adams, R.E.; Tobias, M.L. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 36p. (ORNL/TM—8849-Vol.1). NTIS, PC A03/MF A01 - GPO. Order Number DE84002929.

This report summarizes progress for the Aerosol Release and Transport Program sponsored by the Nuclear Regulatory Commission's Office of Nuclear Regulatory Research, Division of Accident Evaluation, for January-March 1983. Topics discussed include (1) the source-term experimental program in the Fuel Aerosol Simulant Test (FAST) Facility; (2) aspects of NSPP experiments 521 and 531 involving the generation of concrete aerosols in steam and air; (3) an experiment in the CRI-II facility on a zinc aerosol and its comparison with an earlier cadmium experiment; (4) core-melt experiments concerning noble metal volatility suppression by molten stainless steel; (5) rare-earth fission-element volatility; (6) development of core-melt experimental facilities; and (7) various analytical activities in support of FAST/CRI-III and NSPP experiments, including code implementation.

4756 **(NUREG/CR—3492-Vol.1) High-temperature gas-cooled reactor safety studies for the Division of Accident Evaluation. Quarterly progress report, January 1-March 31, 1983. Volume 1.** Ball, S.J.; Cleveland, J.C.; Conklin, J.C.; Harrington, R.M.; Lindemer, T.B.; Siman-Tov, I. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 32p. (ORNL/TM—8921/V1). NTIS, PC A03/MF A01 - GPO. Order Number DE84002501.

Work continued on high-temperature gas-cooled reactor safety research directed towards both the Fort St. Vrain and 2240-MW(t) lead plant reactors. Code development and verification activities addressed simulations of unrestricted core heatup accidents, steam generator and turbine-plant perturbations, and fission-product redistribution during severe accidents. Analyses and sensitivity studies of the lead plant thermal response were made for postulated severe accidents, and partial pressures of pertinent reactor materials were calculated for the resulting severe accident environment.

4757 **(PNL-SA—11420) COBRA/TRAC simulation of a semiscale small break LOCA.** Bian, S.H.; Thurgood, M.J.; Kelley, J.M. (Pacific Northwest Lab., Richland, WA (USA)). Jun 1983. Contract AC06-76RL01830. 7p. (CONF-831047—96). NTIS, PC A02/MF A01. Order Number DE84002589.

From American Nuclear Society winter meeting; San Francisco, CA, USA (30 Oct 1983).

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The COBRA/TRAC computer program has been developed to predict the thermal-hydraulic response of nuclear reactor primary coolant systems to small and large break loss-of-coolant accidents and other anticipated transients. The code solves the compressible three-dimensional, two-fluid, three-field equations for two-phase flow in the reactor vessel. The three fields are the vapor field, the continuous liquid field, and the liquid drop field. A five-equation drift flux model is used to model fluid flow in the primary system piping, pressurizer, pumps, and accumulator. In the code modeling of Semiscale Test S-UT-2, the intact and broken loops, and the upper head injection (UHI) systems are represented by one-dimensional components,. The pressure vessel and two steam generators are modeled using the three-dimensional VESSEL compo-

nent. The results from the COBRA/TRAC calculation give a reasonable match with the measured data.

4758 **(SAND—83-1823C) Hydrogen safety aspects for LWRS.** Camp, A.L.; Berman, M. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 45p. (CONF-8310143—23). NTIS, PC A03/MF A01. Order Number DE84002044.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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This paper describes recent results produced at Sandia National Laboratories in a program to study hydrogen behavior in light water reactors. During the past year, new experimental facilities were produced, construction of new experimental facilities was completed, and additional analytical capability was developed. The paper is divided into sections dealing with deflagrations, diffusion flames, accelerated flames and detonations, and recent analytical accomplishments. Also, a bibliography of reports and papers completed in FY 83 is presented.

4759 **(SAND—83-1834C) RELAP5/MOD1 assessment conclusions.** Kmetyk, L.N. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 19p. (CONF-8310143—7). NTIS, PC A02/MF A01. Order Number DE84001545.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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The RELAP5 independent assessment project is part of an overall effort to determine the ability of various systems codes to predict the detailed thermal/hydraulic response of LWRs during accident and off-normal conditions. The RELAP5/MOD1 code has been assessed against a variety of test data from both integral and separate effects test facilities.

4760 **(SAND—83-2006) Light Water Reactor Safety Technology Program. Quarterly report, April-June 1983.** (Sandia National Labs., Albuquerque, NM (USA)). Nov 1983. Contract AC04-76DP00789. 32p. NTIS, PC A03/MF A01. Order Number DE84003329.

The Program was initiated in FY 1978 and has evolved during FY 1979 through FY 1982. The areas of activity during the last quarter are reported and have been broadly categorized as follows: risk methods utilization; man-machine interface; safety data; utility training; information systems; and integrated approach demonstrations.

4761 **(WAPD-TM—1544) Best estimate analysis of the LOFT L3-6 small-break loss-of-coolant experiment and the L8-1 severe core-transient experiment using the FLASH7 computer program.** Lai, C.K. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Oct 1983. Contract AC11-76PN00014. 52p. NTIS, PC A04/MF A01. Order Number DE84001917.

The LOFT L3-6/L8-1 small break loss-of-coolant experiment conducted in the Loss-of-Fluid Test (LOFT) facility at Idaho is analyzed using the FLASH7 computer program. Experiment L3-6 was designed to evaluate the effects of primary coolant pump operation during a small-break loss-of-coolant accident (LOCA). Experiment L8-1 was the first severe core transient experiment in which the reactor core was uncovered. The analysis was performed on a best estimate basis as part of the overall effort to qualify FLASH7 as a calculational tool for reactor safety analysis. Results of the FLASH7 simulation are presented and compared with L3-6/L8-1 experimental data. The comparisons indicated that the FLASH7 computer program adequately calculates the behavior of the important hydraulic parameters during both the blowdown and the reflood phases of a small break LOCA. Core thermal response, including fuel temperature excursion during core uncovery was also predicted with reasonable accuracy. 36 figures.

4762 **Evaluation of volatile and gaseous fission product behavior in water reactor fuel under normal and severe core accident conditions.** Rest, J. (Argonne National Laboratory, Materials Science Division, 9700 South Cass Avenue, Argonne, Illinois 60439). *Nuclear Technology;* **61**: No. 1, 33-48(Apr 1983).

As the noble gases play a major role in establishing the interconnection of escape routes from the interior to the exterior of nuclear reactor fuel, a realistic description of the release of volatile fission products (VFPs) must a priori include a realistic description of fission gas release and swelling. In addition, as the VFPs are, in general, quite soluble in the fuel matrix and are known to react with other elements to form compounds, a realistic description of VFP release must include the effects of VFP chemistry on VFP behavior. The steady-state and transient gas release and swelling subroutine, FASTGRASS, has been modified to include a mechanistic description of the behavior of VFPs (iodine, cesium, CsI, Cs_2MoO_4, and Cs_2UO_4). Phenomena modeled are the chemical reactions between the VFPs, VFP migration through the fuel, and VFP interaction with the noble gases. Calculations were performed with FASTGRASS to describe the release of noble gases, iodine, cesium, and CsI from light water reactor fuel during steady-state and powerramping conditions. Key issues that are addressed in the analysis are the effects of (a) VFP chemistry, (b) various assumptions concerning mechanisms of VFP migration through solid UO_2, (c) fission gas behavior, and (d) an accident scenario on the chemical form of the released iodine and the rate of iodine release from water reactor fuel.

4763 **Effect of helium pressure on the response of unirradiated UO_2 subjected to thermal transients.** Fenske, G.R.; Chapello, P.M.; Emerson, J.E.; Poeppel, R.B. (Argonne National Laboratory, Materials Science and Technology Division, 9700 South Cass Avenue, Argonne, Illinois 60439). *Nuclear Technology;* **61**: No. 1, 100-112(Apr 1983).

The effect of helium pressure on the transient response of unirradiated depleted UO_2 subjected to simulated hypothetical loss-of-flow accidents in a gas-cooled fast reactor was examined by use of the direct electrical heating technique. Transient tests were performed at pressures ranging from 7 to 10 X 10^5Pa(7 to 10 atm) to 7 to 8 MPa (70 to 80 atm) on radially restrained and unrestrained fuel segments. The average heating rates ranged from about17 to 240 J/g x s. The results indicate that while the mechanical integrity of the fuel segment was independent of the test pressure, the rapid ejection of molten fuel from pellet interfaces of unrestrained fuel, observed at the lower pressures, was delayed or suppressed at the higher pressures.

4764 **On combining data for estimating the frequency of low-probability events with application to sodium valve failure rates.** Martz, H.F.; Bryson, M.C. (Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Nuclear Science and Engineering;* **83**: No. 2, 267-280(Feb 1983). (In Russian).

Probabilistic risk assessments are increasingly being used to quantify the public risks of operating potentially hazardous systems such as nuclear power reactors. Such assessments require the quantification of the frequencies of various low-probability events. In performing these analyses, the risk analyst is often confronted with the dual problem of the appropriate data to be used to estimate the required frequencies and the development of the corresponding estimates. Often the problem reduces to one of how to combine (or pool) a variety of more or less applicable existing data sources. A Bayes/empirical-Bayes procedure is developed for combining as many as five different types of pertinent data. The five data types can be grouped under analysis data, similar operating data, expert opinions, historical operating data, and generic data. Example illustrations of each of these data types are given. The procedure is used to estimate the combined hourly failure rate of small manually operated sodium valves, such as those typically found in liquid-metal fast breeder reactor shutdown heat removal systems. Pertinent data sources include operating data from sodium test loops (similar operating data), expert opinion, operating data from the Experimental Breeder Reactor-II, and seven generic failure rate estimates for similar valves in both U.K. and U.S. operating light

water power reactors. A final posterior distribution is produced that reflects the combined influence of all of these data. This distribution provides the required estimates and corresponding uncertainty bounds.

4765 **Nuclear power plant piping damping parametric effects.** Ware, A.G. (EG & G Idaho Inc., Idaho Falls, Idaho). *American Society of Mechanical Engineers,* [*Paper*]; No. 83-PVP-67, 8(1983). (CONF-830607—). Contract AC07-76ID01570.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

The present NRC guidelines for structural damping to be used in the dynamic stress analyses of nuclear power plant piping systems are generally considered to be overly conservative. As a result, plant designers have in many instances used a considerable number of seismic supports to keep stresses calculated by large scale piping computer codes below the allowable limits. In response to this problem, the NRC and EG & G Idaho are engaged in programs to evaluate piping system damping, in order to provide more realistic and less conservative values to be used in seismic analyses. To generate revised guidelines, solidly based on technical data, new experimental data need to be generated and assessed, and the parameters which influence piping system damping need to be quantitatively identified. This paper presents the current state-of-the-art knowledge in the United States on parameters which influence piping system damping. Examples of inconsistencies in the data and areas of uncertainty are explained. A discussion of programs by EG & G Idaho and other organizations to evaluate various effects is included, and both short and long range goals of the program are outlined.

4766 **Experience with nonuniform damping in the seismic analysis of nuclear plant components.** Winkel, B.V.; Julyk, L.J. (Westinghouse Hanford Company, Richland, WA). *American Society of Mechanical Engineers,* [*Paper*]; No. 83-PVP-47, 8(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

The seismic response of nuclear power plants is significantly affected by the presence of damping. Current seismic analysis practice generally involves a uniform minimum damping assumption. This conservative approach does not permit taking advantage of the higher damping exhibited by some components within a system model. Various methods for accounting for nonuniform damping in a structural model are reviewed and evaluated. The methods are compared by solving a beam/pipe model subjected to a typical seismic ground motion. A two-degree-of-freedom variable damping parametric study is also presented. Based upon the experience of evaluating and applying the available methods, application guidelines are presented.

4767 **Thermal-hydraulic-structural behavior of the EBR-II IHX for overpower transients.** Mohr, D.; Chang, L.K.; Lee, M.J.; Feldman, E.E. (Argonne National Lab., IL). *American Society of Mechanical Engineers,* [*Paper*]; 1-7(1982). Contract W-31-109-ENG-38.

A detailed study has been made of the effects of the Operational Reliability Testing (ORT) program on major plant components of the Experimental Breeder Reactor No. II (EBR-II). This paper describes the integrated thermal-hydraulic-structural analyses conducted for the intermediate heat exchanger (IHX) with the aid of the NATDEMO, THTB, and ANSYS codes. An extensive analysis revealed the stress limiting area to be the junction between the upper head and upper tube sheet. The analyses indicate, however, that the EBR-II IHX, the major plant component most affected by the ORT program, will be able to withstand the thermal stress and accumulated fatigue damage during the lifetime of the plant including the ORT program.

4768 **Analysis of CRBRP station blackout using SSC/MINET.** Van Tuyle, G.J. (Brookhaven National Laboratory, Upton, NY). *American Society of Mechanical Engineers,* [*Paper*]; No. 82-NE-19, 7(1982). (CONF-820705—).

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

A steam generator system transient analysis package (MINET), recently incorporated into the SSC code (a nuclear power plant systems analysis code), is reported. Essentially a code within a larger code, MINET is so named because it is based on a momentum integral network method. Since the SSC code is being used extensively in the analysis of the Clinch River Breeder Reactor Plant (CRBRP), an analysis of the CRBRP steam generator system, using MINET, is reported. Plant transient data are generally unavailable for such advanced power plants, therefore, results from computer analysis of a CRBRP station blackout event, using the DEMO code, are shown. Comparable SSC/MINET analysis provided similar results, particularly when two specific DEMO assumptions were factored into the MINET calculations. A more extensive SSC/MINET analysis of a CRBRP station blackout event, with pony motors and auxiliary feedwater pumps unavailable, is also reported.

4769 **TRAC-P1A assessment of a loss-of-coolant accident in the semiscale MOD-3 facility.** Pyum, J.J. (University of California, Los Alamos National Laboratory, Computational Physics Group, Applied Theoretical Physics Division, P.O. Box 1663, Los Alamos, New Mexico 87545). *American Society of Mechanical Engineers,* [*Paper*]; No. 82-NE-14, 5(1982). (CONF-820705—).

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

The TRAC (Transient Reactor Analysis Code) is being developed at the Los Alamos National Laboratory as an advanced "bestestimate" computer program for analysis of postulated hypothetical accidents in pressurized water reactors. As a part of the TRAC independent assessment efforts, a TRAC posttest analysis of Semiscale Mod-3 Test S-07-6 was conducted. The result of this analysis shows that the agreement between TRAC calculation and experimental data is not very good. In particular, TRAC does not predict the long term downcomer and core liquid level oscillations during the reflood phase.

4770 **Shutdown transients for a LMFBR plant with a superheated steam cycle.** Gross, M.; Noe, D.; Province, R. (Westinghouse Electric Corporation, Advanced Reactors Division, Madison, PA). *American Society of Mechanical Engineers,* [*Paper*]; No. 82-NE-23, 8(1982). (CONF-820705—). Contract AC06-79ET37107.

From 2. joint ASME/ANS nuclear engineering conference; Portland, OR, USA (25 Jul 1982).

The transient analysis of LMFBRs represents an important factor in the design of the reactor, plant systems, and components. Because of high operating temperatures, large temperature differentials, low coolant heat capacity, and the high coolant to metal heat transfer coefficients, the plant shutdown transient usually results in significant temperature changes. The resulting thermal stresses significantly influence the design and analysis of components. This paper discusses the transient response of a LMFBR with a superheated steam cycle.

4771 **Possibilities of hydrogen removal. Final report.** Baukal, W.; Koehling, A.; Langer, G.; Poeschel, E. Frankfurt am Main, Germany, F.R.; Battelle-Institut e.V. (1981). 277p. (In German). Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

The study investigates evolution of hydrogen in design-basis accidents and in three hypothetical accident scenarios for a 1300-MW PWR. One of these scenarios is derived from the loss-of-coolant accident, while the other two assume rapid release of large volumes of hydrogen (failure of emergency cooling system; core meltdown). Limit values were determined for the minimum throughput required for a hydrogen removal system and for the latest possible time of loading of the system after the beginning of the accident. The objective in all cases is to keep the hydrogen concentration in the containment atmosphere at or below 4 percent volume. As removal methods the catalytic and thermal recombination, combustion recombiner, and area recombiner have been regarded. A comparison of the methods showed that the first two methods are the most promising measures.

4772 **Evacuation of Mississauga. Experience and analysis with regard to the German emergency provisions. Final report on research project St. Sch. 776.** Hesel, D.; Schnadt, H. Koeln, Germany, FR.; Technischer Ueberwachungs-Verein Rheinland e.V. (1981). 89p. (In German). Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R).

For the emergency provisions of German NPP-sites experiences are analyzed that have been made with the railway accident in Mississauga, Ontario/Canada on 10.11.1979 and the subsequent evacuation of about 220000 people. The primary purpose of the analysis is to conceive the phenomena of an emergency process and to find explanations for the behaviour of persons and organizations. First ways to improve the emergency provisions shall be deducted from that analysis.

25 ENERGY STORAGE

2505 Flywheels

REFER ALSO TO CITATION(S) 5032

2509 Batteries

REFER ALSO TO CITATION(S) 4925

4773 **(LBL—16806) Thermodynamic framework for estimating the efficiencies of alkaline batteries. Final report.** Pound, B.; Sundararaj, B.; Singh, R.P.; Macdonald, D.D. (Ohio State Univ., Columbus (USA); Lawrence Berkeley Lab., CA (USA)). Oct 1983. Contract AC03-76SF00098. 76p. NTIS, PC A05/MF A01. Order Number DE84003921.

A thermodynamic framework was developed to evaluate the efficiencies of alkaline battery systems for electrolyte concentrations from 1 to 8 mol kg^{-1} and over the temperature range -10 to 120°C. An analysis of the thermodynamic properties of concentrated LiOH, NaOH, and KOH solutions was carried out to provide data for the activity of water, the activity coefficient of the hydroxide ion, and the pH of the electrolyte. Potential-pH relations were derived for various equilibrium phenomena for the metals Li, Al, Fe, Ni, and Zn in aqueous solutions, and using the thermodynamic data for the alkali metal hydroxides, equilibrium potentials were computed as a function of composition and temperature. These data have then been used to calculate reversible cell potentials for a number of battery systems, assuming a knowledge of the cell reactions. The calculated reversible cell voltages are then compared with observed cell voltages to compute voltage efficiencies for various alkaline batteries. The cell voltages varied with concentration of alkali metal hydroxide and temperature in a manner depending on the particular battery. In the case of the Al/air, Zn/air, and Zn/Ni systems, the cell voltage increased with concentration but decreased with an increase in temperature. In contrast, the Li/air and, to a lesser extent, the Fe/air cells exhibited the opposite behavior, while the cell potentials of the Fe/Ni system decrease with an increase in either concentration or temperature. The potential of the H_2/Ni cell, however, is independent of concentration but does decrease with temperature. The efficiencies of H_2/Ni, Fe/Ni, and Zn/Ni test cells were found to be between 90 to 100%, implying that, at least at open circuit, there is little, if any, contribution from parasitic redox couples to the cell potentials for these systems. The efficiency of an Fe/air test cell was relatively low (72%), but this may be determined by the nature of the redox couple at the air electrode.

4774 **(SAND—83-0979C) Effects of water on the cathode passivation by lithium dithionite in the Li/SO_2 battery.** Whiteley, R.V. Jr.; Blasi, J.A. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 12p. (CONF-831086—8). NTIS, PC A02/MF A01. Order Number DE84003103.

From Electrochemical Society fall meeting; Washington, DC, USA (9 Oct 1983).

The electrochemical reduction of SO_2 from a LiBr/acetonitrile solution leads to the formation of a passivating lithium dithionite ($Li_2S_2O_4$) film on the cathode. The passivation of a glassy carbon electrode can be enhanced by adding alkaline materials (e.g., Li_2CO_3) to the electrolyte. Conversely, when water (≧ 100 ppM) is added to the system, the effects of the dithionite film are diminished. Although the passivation of the cathode is observed for the electroreduction of dilute (< 10 mM) as well as concentrated (≧ 1 M) SO_2 solutions, the depassivation of the film by water is observed only when water is added to a concentrated electrolyte solution. Multiple scan cycle voltammetry has been used to monitor the extent of cathode passivation as a function of water content (≦ 1000 ppM). Several mechanisms for the apparent depassivation are postulated, and each is addressed using chronoamperometry and cyclic chronocoulmetry. It has been concluded that the water in the electrolyte increases the conductivity of the dithionite film.

4775 **(SAND—83-1082C) Membrane separators for circulating electrolyte storage batteries.** Assink, R.A.; Arnold, C. Jr. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 10p. (CONF-831086—7). NTIS, PC A02/MF A01. Order Number DE84002106.

From Electrochemical Society fall meeting; Washington, DC, USA (9 Oct 1983).

Separator membranes are often the technologically limiting factor in the performance of flowing electrolyte batteries. Several studies designed to understand and improve their performance have been completed. The increased resistance of an anionic membrane when placed in a $FeCl_3$ solution was related to a decrease in the water content of the membrane. A factorial study was used to examine the structure-property relationships of anionic permselective membranes. A conductivity model successfully related the resistance of a membrane to its ion exchange capacity and water content.

4776 **Morphological studies on the Li-Al electrode in fused salt electrolytes.** Fischer, A.K.; Vissers, D.R. (Argonne National Laboratory, Chemical Engineering Division, Argonne, Illinois). *Journal of the Electrochemical Society;* **130**: No. 1, 5-11(Jan 1983). Contract W-31-109-ENG-38.

Well-functioning Li-Al electrodes in Li-Al/FeS cells have an open, coral-like structure. Occasionally, a coalesced zone develops that is believed to cause a decline in capacity. Comparative morphology experiments suggest that β-Li-Al, as well as α-Li-Al, is involved in the development of coalescence in Li-Al electrodes operating in fuse salt electrolytes. The course of developing coalescence is viewed as a sintering process; it is hypothesized that there is a contribution to this process from electrochemically formed diffusive pathways that develop between particles of β-Li-Al. Local overpotential is regarded as important in forming these pathways. A significant impact on the rate of coalescence is expected from the high lithium vacancy concentration and chemical diffusion coefficient in β-Li-Al. There is a clear correlation between coalescence and charging of the electrode. Variation of current density and electrolyte composition alone did not, within the range of the experiments, prevent coalescence.

4777 **Effective conductivities of a positive electrode in an Li-Al/FeS cell at different states of charge.** Hiro, M.; Shimotake, H. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois). *Journal of the Electrochemical Society;* **130**: No. 1, 12-16(Jan 1983).

Effective conductivities of porous electrodes containing FeS as the initial active material and 54 weight percent (w/o) LiCl-KCl electrolyte were experimentally determined at 450°C for different states of charge by means of an a-c impedance bridge. The effective conductivity of the fully charged FeS electrode was found to be approximatel 7 Ω^{-1} X cm^{-1}, about four times higher than the conductivity of the electrolyte. This high effective conductivity is considered to be one of the superior features of the FeS cells because such high conductivity results in high power density without the addition of conductive material. The change of the electrode effective resistance during the discharge is discussed in connection with both the electrode reactions and the results of metallographic examinations.

4778 **Ceramic separators for Li-Al/iron sulfide batteries.** Bandyopaphyay, G.; Battles, J.E.; Swaroop, R.B. (Argonne National Laboratory, Argonne, IL). *Journal of the Electrochemical Society;* **129**: No. 10, 2187-2194(Oct 1982).

Woven fabric, felt, powder, and sintered ceramic separators have been considered for application in Li-Al/FeS /SUB x/ cells. The performances of representative samples of these separator types in laboratory- and engineering-size Li-Al/FeS cells were analyzed to correlate in a quantitative manner the relationship among separator characteristics (tortuosity, thickness, and porosity), current density, and active material utilization. A similar approach can be used to develop a quantitative relationship for larger size cells from a limited number of well-characterized experiments and should be of considerable value to cell designers. The results from post-test examinations of laboratory-size cells indicate that BN felt, MgO powder, and sintered MgO separators are chemically and mechanically stable in the cell environment.

4779 **Thermomechanical behavior of simulated negative electrodes for Li-Al/FeS battery cells.** Banoyopadhyay, G.; Battles, J.E. (Argonne National Laboratory, Argonne, Illinois). *Journal of the Electrochemical Society;* **129**: No. 10, 2265-2267(Oct 1982).

Negative electrodes in Li-Al batteries typically generate a porous, machanically stable microstructure. But agglomeration, associated with nonuniform elimination of porosity, have been detected. Agglomeration is the result of excessive sintering of the negative electrode. Excessive agglomeration can lead to poor utilization of active materials and may result in nonuniform swelling stresses. This paper collects data on the sinterability and deformability of simulated negative electrode compositions, in order to help prevent or minimize agglomeration. Aluminum and beta-Li-Al were each blended with eutectic LiCl-KCl salt and then cold pressed to form compacts. Beta-Li-Al compacts were much more deformable than Al specimens. The different deformation is evidently related to the lack of sintering in beta-Li-Al.

29 ENERGY PLANNING AND POLICY

REFER ALSO TO CITATION(S) 4357, 5652

4780 **(DOE/S—0025-Vol.2) Assessment of the relationships between the Department of Energy and universities and colleges. Volume II. Support studies for the University Programs Panel.** Dailey, N.S.; English, M.R.; Lambright, W.H.; Watts, A.D.; West, C.D.; Wilbanks, T.J. (USDOE Office of Energy Research, Washington, DC. University Programs Panel). 11 Oct 1983. 184p. NTIS, PC A09/MF A01. Order Number DE84002178.

The report is divided into six sections: (1) a collection and summarization of statistical data and relevant information that delineates the scope and trend of government R and D, (2) a review of the responses to DOE's request for input from the academic community and others, (3) a discussion of the relationships between universities and the DOE laboratories, (4) a description of different types of university/government relationships, (5) a discussion of novel roles for the universities, and (6) a review of 24 reports on the status of government/university relationships. An extensive bibliography concerning the roles of government and universities in energy R and D is also included. The review paper outlines the major issues, conclusions, and recommendations presented in the 24 studies. The extensive bibliography was prepared to provide a relevant information base for the Panel's reference and for use by the supporting staff.

4781 **(GAO/GGD—83-39) Better use of information technology can reduce the burden of federal paperwork.** Bowsher, C.A. (General Accounting Office, Washington, DC (USA). Office of the Comptroller General). 11 Apr 1983. 47p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to the Committee on Government Operations, House of Representatives.

The Federal Government has made significant progress in reducing the public's information reporting burden by simplifying and eliminating forms and by other means. Little is being done by OMB and federal agencies, however, to use information technology to further reduce business and government paperwork burden and reduce associated costs. There are over 3300 information reporting requirements levied on businesses by the Federal Government. GAO performed case studies of four of these. In each case, GAO found that submission of the required data through automated means such as magnetic tape, disk, or telecommunications would significantly reduce paperwork burden and improve the efficiency of the data collection operations. Strong leadership by the Office of Management and Budget and increased emphasis by federal managers are needed to capitalize on the potential benefits of using information technology in federal data collection activities.

4782 **(GAO/RCED—83-196) Data on DOE's uranium power contracts and the cost of power.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 15 Jul 1983. 14p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

This report answers questions about the electric power contracts in DOE's uranium enrichment program. The amount of power not taken or not expected to be taken by DOE was verified with the actual contracts and the applicable subsequent modifications to the contracts, and with the fiscal year 1983 thru 1995 DOE Uranium Enrichment Operating Plan. Contractual information was compared with the actual power contracts and their modifications. The reasonableness of DOE's fiscal year 1983 projected power rates and the selection of key contract terms with TVA; Electric Energy, Inc.; and the Ohio Valley Electric Corporation was checked. The accuracy of the computer model DOE used to determine the impact of different power rates on its enrichment price was not examined.

2901 Energy Analysis And Modeling

4783 **(DOE/EI/08607—T2) Wharton Annual and Industry Forecasting Model: structure and specification.** (Wharton (E.F.A.), Inc., Philadelphia, PA (USA)). Apr 1980. Contract AC01-77EI08607. 124p. NTIS, PC A06/MF A01. Order Number DE84002236.

Portions are illegible in microfiche products.

A large-scale macroeconometric model of the US economy designed for purposes of long-term forecasting (ten to twenty years) and analysis of economic policies is presented. Its basic design places great emphasis on the technological and supply-side relationships and contains over 2100 variables. The production sector of the model identifies 56 producing industries, while final expenditures are disaggregated into over 73 categories. The bridge between the expenditure and production sides of the model is provided by a fully integrated input-output model, which means that final demand and national income determination require simultaneous solution of the input-output system to generate estimates of industrial output. Also, industry prices and implicit final demand deflators cannot be derived without the simultaneous interaction of relationships in the macro model and the input-output system. This model also incorporates the results of major research efforts in the areas of energy-economy interactions and the role of demographics in the supply and expenditure sides of the economy.

4784 **(DOE/EI/08607—T3) Development of an analytical procedure for the evaluation of the effect of energy price increases on non-energy commodities.** Guill, G.D.; Schink, G.R.; Sheinin, Y. (Wharton (E.F.A.), Inc., Philadelphia, PA (USA)). Apr 1980. Contract AC01-77EI08607. 191p. NTIS, PC A09/MF A01. Order Number DE84002234.

Portions are illegible in microfiche products.

This document presents results of tasks assigned to: develop and implement a procedure to identify energy price effects on selected final expenditure deflators, develop and implement a procedure to identify energy price effects on non-energy industrial prices, and develop a procedure for the conversion of producers' prices to purchasers' prices. This documentation includes the Wharton Annual Model Equation Book, Volume 1 and 2 as well as a

comparison paper Wharton Annual and Industry Forecasting Model: Structure and Specification.

4785 **(DOE/EIA—0426) Effects of lower world oil prices.** Dickens, P.F. III; Curtis, W.P.; Rasmussen, J.; Trapmann, W. (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). Oct 1983. 32p. NTIS, PC A03/MF A01 - GPO. Order Number DE84002953.

This report explores some of the effects of oil price declines using projections prepared for the recent 1982 Annual Energy Outlook. The focus is on the projections employing the lowest of three projected world oil price paths. The topics addressed are: the general level of energy use; changes in the relative use of enery forms; effects on the domestic oil production and producers; and effects on the general economy and the federal budget.

2902 Economics And Sociology

REFER ALSO TO CITATION(S) 4384, 4518, 4783, 4785, 4837, 4839, 5392, 5393

4786 **(DOE/CS/01220—T1) Energy Education and Conservation Project. Final report.** (Massachusetts State Labor Council, AFL-CIO, Boston (USA)). [nd]. Contract FG01-78CS01220. 15p. NTIS, PC A02/MF A01. Order Number DE84003049.

The Project has proven that ongoing and in-depth communication between organized labor plus state and national government agencies is beneficial to all parties and contributes to the nation's well-being as a whole. The public in general and the labor community in particular have expressed the need for specific and in-depth information about energy conservation, energy efficiency, energy alternatives and energy legislation. Literature distribution continuation is recommended. Communication, cooperation, information and trust are the keys to a successful grassroots energy project.

4787 **(TENRAC/EDF—085-Vol.1) Onshore impacts of offshore oil and gas activities: coastal data inventory. Volume 1. Final report.** (Rice Center, Houston, TX (USA)). Jan 1983. 291p. NTIS, PC A13/MF A01. Order Number DE84900422.

This report presents the results of an inventory of economic, demographic and facilities data available to support the assessment of economic impacts of offshore oil and gas activities on Texas coastal communities. Several key items for the impact assessment activities of this project were available (when available at all) only from primary sources. Those items included employment data for the relevant portion of the petroleum industry, local government service provision and cost information, and expectations of future offshore oil and gas activity levels. Primary data collection was carried out for only a few selected case study areas, therefore, this document presents in almost all cases the information available from secondary sources, including data generated by combining information from multiple sources. Secondary source data were gathered primarily by telephone or mail request from public and university libraries, relevant state and federal agencies, from cooperating coastal communities, and from representatives of the oil and gas industry.

4788 **(TENRAC/EDF—085-Vol.3) Onshore impacts of offshore oil and gas activities: issues and implications. Volume III. Final report.** (Rice Center, Houston, TX (USA)). Mar 1983. 98p. NTIS, PC A05/MF A01. Order Number DE84900421.

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The results of the study indicated that, at least in the near future, coastal communities may not be able to garner an equitable rate of return on their investment for service provision supporting the development of state and federal offshore reserves. In the situations analyzed with four Texas coastal communities, it appears that this projected imbalance in investment return is not great, but is sufficient to cause significant impact on the communities and their individual and corporate residents. This view of offshore development of public resources provides a basis for both federal and state involvement in mitigating the impacts projected to be experienced by Texas communities. Implementation of any of the suggested strategies will require the cooperation of all parties: the private sector, the local communities and the state and federal governments. Involvement of each party may vary from technical assistance, to legislative action to actual construction of facilities. The level of possible state involvement likely will be a function of the level of federal response to mitigation of onshore impacts from Outer Continental Shelf development and the degree to which coastal communities are able to generate locally revenues from offshore related activities.

4789 **(TENRAC/EDF—085-Vol.4) Onshore impacts of offshore oil and gas activities. Volume IV. Summary.** (Rice Center, Houston, TX (USA)). Mar 1983. 12p. NTIS, PC A02/MF A01. Order Number DE84900423.

This report presents the results of an analysis of the onshore impacts of Texas offshore oil and gas activities, and the implications of those findings for policy development. The study looked at communities along the Texas coast which were, or were likely to be, impacted by activities associated with offshore drilling and production. The project examined the general economic and demographic impact on the local area, and more especially, the impact on the local public sector to determine whether, and in what form, assistance might be needed by and warranted for coastal communities experiencing effects from offshore activities. For this study, impacts of offshore activity were defined as those measurable changes in oil-related employment, induced changes in other employment and resulting population growth, with attendant costs and revenues for public service providers. Therefore, costs or benefits such as potential risk of environmental damage from oil spills was not within the scope of work. Final deliberations on the impacts of offshore energy development should include in consideration these less quantifiable impacts as well. Use of the restrictive definition of impact produced a conservative estimate of changes in coastal communities attributable to offshore activities, thus mitigating against an overstatement of impacts. It also increased the comparability of coastal impacts with those observed for an inland community.

2903 Environment, Health, And Safety

REFER ALSO TO CITATION(S) 5428

4790 **(GAO/RCED—83-161) Information on ocean disposal of municipal and industrial waste.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 18 May 1983. 42p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to the Chairman, Committee on Merchant Marine and Fisheries, House of Representatives.

The ocean continues to be used for the disposal of municipal and industrial wastes. Ocean dumping could increase in the future depending on economic and environmental considerations and problems with disposal alternatives. While there is a growing interest in making waste disposal decisions only after considering all available options, more information and research are necessary to help Federal and local officials reach disposal decisions that balance the tradeoffs involving land, air, and water alternatives. The Environmental Protection Agency has undertaken or sponsored several projects to improve the state of the art of making waste disposal analyses among available options.

2904 Natural Resources

REFER ALSO TO CITATION(S) 4796, 4853, 4895

4791 **Some industrial viewpoints on national materials policy.** Harwood, J.J.; Layman, R.W. (Ford Motor Co., Dearborn, MI). *Materials and Society;* 7: No. 1, 93-99(1983).

The need for establishing a National Materials Policy in the United States is discussed. Numerous Congressional hearings and legislative offerings, government sponsored commissions and studies, professional society panels and conferences and countless

speeches and debates have focused on the growing dependence of the U.S. on foreign overseas sources of supply of critical and strategic minerals. There are concerns about concentration of minerals reserves in particular countries and geographic areas -- particularly Central and Southern Africa -- and the possibility of geo-political instabilities interfering with mineral accessibility. Related topics discussed are problems affecting our domestic minerals and basic materials industries, the use of Federal lands for mineral exploitation, stockpiling, environmental regulation legislation and other domestic issues. (JMT)

4792 **Elements of strategic planning in the copper nonferrous minerals industry.** Romagnoli, E.A. (ASARCO, Inc., New York, NY). *Materials and Society;* 7: No. 1, 65-70(1983).

From International Minerals Issues: A U.S. Perspective; Washington, DC, USA (8 Nov 1982).

Key elements in strategic planning in the nonferrous mining industry are discussed. Included are price forecasting, financial planning, government relations, research and development, and exploration. Financial planning is discussed in terms of 1) forecasting of earnings, 2) investment policy and 3) tax planning. Costs of environmental liabilities are expected to have a major impact on the industry. (JMT)

4793 **Changing strategic planning processes for a minerals user.** Caswell, W.K. Jr. (United States Steel Corp., Pittsburgh, PA). *Materials and Society;* 7: No. 1, 81-86(1983).

The mineral industry has been affected by the slowed growth of the steel industry. Steel makers have sold mining property and reduced inventories of raw materials. In addition, they now require separation, cleaning, blending, beneficiation and/or first-step processing, and testing of materials. If the steel industry is to earn its position in the marketplace, machinery, manpower and materials must be stringently controlled. (JMT)

4794 **Utilization of science and technology to reduce materials vulnerability.** Bement, A.L. Jr. (TRW Inc., Cleveland, OH). *Materials and Society;* 7: No. 1, 87-92(1983).

President Reagan's National Materials and Minerals Plan and Report to Congress is discussed in a report of testimony before the subcommittee on Science, Technology and Space, June 22, 1982. Included are: 1) perceptions on the nature and seriousness of the strategic materials and minerals issues, 2) the potential of science and technology to reduce U.S. vulnerabilty and 3) ways to enhance the utilization of our scientific and technological capabilities. (JMT)

2905 Research, Development, Demonstration, And Commercialization

REFER ALSO TO CITATION(S) 4278, 4424, 4582, 4838, 4915

4795 **(DOE/S—0025-Vol.1) Assessment of the relationships between the Department of Energy and universities and colleges. Volume 1.** (USDOE Office of Energy Research, Washington, DC. University Programs Panel). Aug 1983. 110p. NTIS, PC A06/MF A01. Order Number DE84002179.

This study examined the entire spectrum of the Department's relationships with and programs for universities and university scientists and students. This included the direct support provided by Department programs for on-campus research and related manpower development and the indirect, but substantial, assistance provided through the Department's national laboratories to university faculty and students. A series of indepth case studies and assessments were also carried out on a number of past and current programs involving universities. Seven major issues and concerns which require attention if the Department's relationships with the academic community are to be strengthened and improved are identified as: the lack of comprehensive and consistent Department-wide policies toward the involvement and support of universities in energy R & D and related programs; the Department's management and procurement policies and procedures related to the support and oversight of university programs; relationships between the Department's national laboratories and the academic community; participation of university scientists and students in the Department's various energy technology development programs; the Department's role in the development of professional-level manpower; communications between the Department and the academic community; and university involvement in multidisciplinary and interdisciplinary energy R & D. Recommendations are given.

4796 **(TVA/OACD—82/15) Transferring technology from TVA's National Fertilizer Development Center.** Culp, J. (ed.). (National Fertilizer Development Center, Muscle Shoals, AL (USA)). Sep 1982. 31p. NTIS PC A03/MF A01. Order Number DE84900361.

Circular Z-135.

The Tennessee Valley Authority's National Fertilizer Development Center at Muscle Shoals, Alabama, is a research complex supplying much of the world's technology for creating, producing, and introducing new fertilizers. The Center achieves its goals by using the multidisciplinary approach. It relies on cooperative programs with universities and the fertilizer industry to give direction to NFDC research and to help in transferring new technology to those needing it most. These programs - plus royalty free, nonexclusive patents on new fertilizer processes - guarantee rapid and widespread adoption. As a result, the NFDC has improved productivity of American agriculture by increasing the efficiency and profits of farmers and of fertilizer dealers and manufacturers.

4797 **Fiscal year 1984 Department of Energy authorization (fossil energy and basic research). Hearings before the Subcommittee on Energy Development and Applications of the Committee on Science and Technology, House of Representatives, Ninety-Eighth Congress, First Session, February 24, March 2, 3, 16, 17, 1983.** Washington, DC; Government Printing Office (1983). 573p.

Five of a series of nine budget hearings focused on DOE's $1 billion basic energy research programs are included in this volume. The issues receiving special attention were those of research priorities, interagency coordination, university research needs, and technology transfer. The 22 witnesses included Alvin Trivelpiece of the DOE Office of Energy Research and representatives of laboratories, universities, and research institutes and companies. Their statements and responses to committee questions are followed by two additional submissions for the record. (DCK)

2906 Nuclear Energy

REFER ALSO TO CITATION(S) 4421, 4424, 4485, 4582, 4614, 4616, 4627, 4751

4798 **(GAO/RCED—83-151) Analysis of studies on alternative financing for the Clinch River Breeder Reactor.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 12 May 1983. 12p. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20760.

This report discusses: objectives, scope, and methodology for review of financing alternatives; why private financing is being sought; and the impact on the federal government of certain issues raised by changing the existing CRBR arrangements.

4799 **Participation of domestic industries in the manufacture of French nuclear power plants.** Jacob, E. (FRAMATOME/France, Tour Fiat-Cedex 16, 92084, Paris La Defense). *Transactions of the American Nuclear Society;* **42**: 99-100(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4800 **Transfer of manufacturing technology - the Canadian approach.** Pon, G.A.; Boulton, J.; Bulger, W.; Farr, C.J. (Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario K0J 1J0). *Transactions of the American Nuclear Society;* **42**: 100-101(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4801 **Transfer of manufacturing technology from the point of view of the user - Indian experience.** Sethna, H.N.; Srinivasan, M.R. (Dept. of Atomic Energy-India). *Transactions of the American Nuclear Society;* **42**: 102(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4802 **Transfer of manufacturing technology for large light-water reactors.** Sciagata, R. (ANSALDO-Breda/Italy, Ansaldo S.p.A., Viale Sarca 336, 20126, Milano). *Transactions of the American Nuclear Society;* **42**: 103(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4803 **Developing nuclear equipment suppliers.** Lopez Lopez, M.I. (Westinghouse Nucl Espanola/Spain, Calle Agustin de Foxa 29, Piso 8, E-16 Madrid). *Transactions of the American Nuclear Society;* **42**: 103-104(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4804 **Technology transfer of the analysis of nuclear piping components.** Penas, A. (Empresarios Agrupados/Spain, Magallanes 3, Madrid 15). *Transactions of the American Nuclear Society;* **42**: 104-105(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4805 **Transfer of technology in the design of mechanical components.** Carciente, S. (Empresarios Agrupados/Spain, Magallanes 3, Madrid 15). *Transactions of the American Nuclear Society;* **42**: 105-106(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4806 **Major points to be considered for nuclear technology transfer.** Chu, B.P.H. (Taiwan Power Co./Taiwan, 39 E. Hoping Rd., Section 1, Taipei 106). *Transactions of the American Nuclear Society;* **42**: 121-122(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4807 **EdF's experience in development of nuclear power plant staff.** Pecoux, P. (Electricite de France, 1, AV. General De Gualle, 92141 Clamart). *Transactions of the American Nuclear Society;* **42**: 122-123(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4808 **Education and training in Brazil for the nuclear technology transfer program.** Franco, R.R. (IPEN (CEN), Cx. P. 11049 Pinheiros, CEP 01000, Sao Paulo). *Transactions of the American Nuclear Society;* **42**: 136-137(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4809 **Manpower development proposal in the context of nuclear technology transfer.** deLibanati, N.A.; Ranzuglia, H. (CNEA/Argentina, Comision Nacional de Energia Atomica, Av. Del Libertador 8250, 1429, Buenos Aires). *Transactions of the American Nuclear Society;* **42**: 137-138(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4810 **Training in technology transfer (nuclear power plants).** Felgines, M. (Electricite de France, 1, AV. General De Gualle, 92141 Clamart). *Transactions of the American Nuclear Society;* **42**: 139-140(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4811 **Nuclear engineering education in Pakistan.** Rahman, I.; Parvez, A. (Centre for Nuclear Studies/Pakistan, Centre for Nuclear Studies, Pinstech P.O. Nilore, Rawalpindi). *Transactions of the American Nuclear Society;* **42**: 140-141(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4812 **The French nuclear safety training program.** Lebouleux, P.; Nicolet, J.L.; Rollet, P. (CEA/France, Commissariat a l'Energie Atomique, 31-33 Rue de la Federation, 75015, Paris). *Transactions of the American Nuclear Society;* **42**: 152-153(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4813 **Experience of BELGATOM in training of personnel and transfer of technology.** Bairiot, H.; Charlier, A.; Vandenberg, C. (BELGATOM/Belgium, BELGATOM, S.A., 7 rue de la roi, B-1040, Brussels). *Transactions of the American Nuclear Society;* **42**: 153-155(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4814 **Development of a small-computer-code-bank for nuclear engineering education.** Parvez, A.; Arshad, M.; Fatimi, A.T. (Centre for Nuclear Studies/Pakistan, Centre for Nuclear Studies, Pinstech P.O. Nilore, Rawalpindi). *Transactions of the American Nuclear Society;* **42**: 155-156(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4815 **General aspect of the international data transfer.** Mancini, C. (CNEA/Italy). *Transactions of the American Nuclear Society;* **42**: 159(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4816 **Some remarks about the effect of an electronuclear program on economy and employment.** Faure, J. (Electricite de France, 1, AV. General De Gualle, 92141 Clamart). *Transactions of the American Nuclear Society;* **42**: 160-162(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4817 **The factors of successful technology transfer.** Teillac, J. (CEA, Commissariat a l'Enegie Atomique, 31-33 Rue de la Federation, 75015, Paris,). *Transactions of the American Nuclear Society;* **42**: 2(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4818 **The role of government in the field of international nuclear cooperation.** Haunschild, H.H. (Federal Ministry for Research and Technology). *Transactions of the American Nuclear Society;* **42**: 2-3(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4819 **International considerations relating to the transfer of nuclear technology.** Blix, H. (IAEA International Atomic Energy Agency, Box 100, A-1400, Vienna). *Transactions of the American Nuclear Society;* **42**: 4-5(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4820 **The role of public organizations in nuclear technology transfer.** Rodriguez, M.L.; Palomo, L.C. (JEN Junta de Energia Nuclear, Av. Complutense, 22, Madrid 3). *Transactions of the American Nuclear Society;* **42**: 5-6(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4821 **Brazil's general experience in the transfer of nuclear technology.** Fabrico, R.A.C. (Nuclebras, Av. President Wilson, 231 Sala-608, Castelo, 20030, Rio de Janeiro, JF). *Transactions of the American Nuclear Society;* **42**: 6-7(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4822 **Sweden as transferrer of nuclear technology.** Helander, L.I. (ASEA-ATOM, P.O. Box 53, S-721 04 Vasteras 1). *Transactions of the American Nuclear Society;* **42**: 8-9(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4823 **Major issues in transfer of technology to developing countries.** Sabato, J.A. (Fundacion Bariloche, Argentina, Jorge Newberry 2875, 1426, Buenos Aires). *Transactions of the American Nuclear Society;* **42**: 9-11(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4824 **Techniques for international transfer of BWR technology.** Roof, R.R. (General Electric Company, Nuclear Energy Division, 175 Curtner Avenue, San Jose, CA 95125). *Transactions of the American Nuclear Society;* 12-13(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4825 **The importance of technological transfer through a private company.** Cesanelli, O.E.; Maloney, J.E.; Rodruguez, E.A. (CEBTAF, Argentina, Pueyrredon. y Zeballos, 585 Ciudad de Rio Tercero-Cba., Buenos Aires). *Transactions of the American Nuclear Society;* 13-14(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4826 **Advanced technologies on pressurized water reactors and fuel cycles.** Markl, H. (KWU/FRG, Kraftwerk Union AG, Postfach 3220, D-8520, Erlangen). *Transactions of the American Nuclear Society;* **42**: 15-16(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4827 **Nuclear power technology transfer general conditions and experience.** Luxo, A.M. (Sofratome, France, 52, quai de Dion Bouton, 92806, Puteaux). *Transactions of the American Nuclear Society;* **42**: 16-17(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4828 **The American Nuclear Society's role in the transfer of nuclear technology to Japan, Korea, and China.** DuTemple, O.J. (ANS Exec. Dir., USA, American Nuclear Society, 555 N. Kensington Avenue, LaGrange Park, IL 60525). *Transactions of the American Nuclear Society;* **42**: 17-18(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4829 **Transfer of nuclear technology -- an overview.** Crowley, J.H.; Sarram, M. (United Engineers and Constructors Inc., 30 S. 17th Street, Philadelphia, PA 19101). *Transactions of the American Nuclear Society;* **42**: 18-19(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4830 **Nuclear energy: an answer for the newly industrialized countries.** Deval, F.; Durret, L.F. (STEC Int, STEC International, 194, Grance-rue, 92310, Sevres). *Transactions of the American Nuclear Society;* **42**: 20(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4831 **Experience of nuclear and plant engineering technology transfer of a reactor supplier in Japan.** Yoshijima, S.; Ogawa, N. (Toshiba Corporation, 72, Horikawa, Saiwai-ku, Kawasaki-shi 210). *Transactions of the American Nuclear Society;* **42**: 20-23(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4832 **The paradox of the technological gap.** Boix Amat, P.A. (AATN/Argentina, Techint S.A., C.M. della Paolera 299, 1104, Buenos Aires). *Transactions of the American Nuclear Society;* **42**: 23-24(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

4833 **Technology transfer at Three Mile Island unit.** Burton, H.M.; Bixby, W.W. (EG & G Idaho Inc., P.O. Box 1625, Idaho Falls, ID 83415). *Transactions of the American Nuclear Society;* **42**: 24-25(Nov 1982). (CONF-821104—).

From 2. international conference on nuclear technology transfer; Buenos Aires, Argentina (1 Nov 1982).

2907 Transport And Storage

REFER ALSO TO CITATION(S) 4347, 4424

2908 Waste Heat Utilization

REFER ALSO TO CITATION(S) 4889

2910 Conservation

REFER ALSO TO CITATION(S) 4878, 4882, 4890

4834 **(SERI/SP—744-606) What your community can do about energy.** (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract AC02-77CH00178. 30p. NTIS, PC A03/MF A01. Order Number DE84003586.

This booklet describes what many communities are doing now about energy. Ways to get started in your own community and where to go for more information and assistance are suggested. (MHR)

2920 Supply, Demand, And Forecasting

REFER ALSO TO CITATION(S) 4354, 4388, 4846

4835 **(N—8326196) Energy remote sensing applications projects at the NASA Ames Research Center.** Norman, S.D.; Likens, W.C.; Mouat, D.A. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). 1982. 9p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 543-551 (SEE N83-26176 15-43).

The NASA Ames Research Center is active in energy projects primarily in the role of providing assistance to users in the solution of a number of problems related to energy. Data bases were produced which can be used, in combination with other sources of information, to solve spatially related energy problems. Six project activities at Ames are described which relate to energy and remote sensing. Two projects involve power demand forecasting and estimations using remote sensing and geographic information systems two others involve transmission line routing and corridor analysis one involves a synfuel user needs assessment through remote sensing and the sixth involves the siting of energy facilities.

2930 Policy, Legislation, And Regulation

REFER ALSO TO CITATION(S) 4400, 4401, 4424, 4582, 4797, 4840

4836 **(N—8326199) Seattle's system for evaluating energy options.** Logie, P.; Macdonald, M.J. (Seattle, City of, WA (USA)). 1982. 8p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 589-596 (SEE N83-26176 15-43).

In 1975, the City Council developed a blueprint called Energy 1990 for meeting Seattle's future electric energy needs. Priorities for addressing or offsetting expected growth in demand are in order: (1) conservation (2) hydroelectricity (3) other renewable sources such as wind, biomass, solar, and geothermal energy (4) abundant nonrenewable resources such as coal, and (5) other renewables. An energy resources planning group was formed and a data base was established. Resource options were investigated and the recommendations were published.

4837 **(TENRAC/EDF—083) Community impacts of lignite and coal development in Texas: legislative report. Final report.** Van Zandt, T.; Hicks, S.; Cross, E.; Bagwell, J.A. (Espey, Huston and Associates, Inc., Austin, TX (USA)). Nov 1982. 206p. NTIS, PC A10/MF A01. Order Number DE84900405.

The strong commitment of Texas energy future to lignite will not be without problems. The next 15 to 20 years will witness a marked increase in surface mine and power plant development in the lignite-rich areas of East and East-Central Texas. In the long-term, the growth generated by this industrial activity is expected to provide economic benefits to these areas, but during the early years of intense growth, many communities may experience significant social and economic disruptions. In recognition of these potential community effects, the Texas Energy and Natural Resources Advisory Council (TENRAC) requested Espey, Huston & Associates, Inc. to initiate a study to determine the nature and extent of these impacts and to assess alternative state-level policy responses to them. The study consisted of three interrelated efforts: (1) based upon the best available data on planned lignite projects and current projections of power demand, several lignite development scenarios were constructed. These projections of mine and plant development were then translated into expected employment, the critical determinant of community growth; (2) an analysis of community growth management capabilities under existing Texas law and policies was conducted to assess how well local governments are likely to cope with the effects of growth; and (3) an investigation of alternative laws, programs, and policies was undertaken, based upon the impact management experience in other states and upon an assessment of the opportunities and shortcomings inherent in existing laws and policies in Texas. The results and recommendations based upon these efforts are summarized briefly.

4838 **Energy Department budget for Fiscal Year 1984. Hearings before the Subcommittee on Energy Conservation and Power of the Committee on Energy and Commerce, House of Representatives, Ninety-Eighth Congress, First Session, March 16 and 17, 1983.** Washington, DC; Government Printing Office (1983). 327p.

Energy Secretary Donald Hodel was the first witness of a two-day hearing to consider the DOE performance and 1984 budget. Chairman Ottinger expressed displeasure with DOE's flaunting of Congressional intent on energy matters and its overemphasis of nucear energy to the near exclusion of solar energy and conservation. There was also concern with the increase in the weapons portion of the budget and plans for private financing of the Clinch River Breeder Reactor. Hodel responded to these and other questions in his testimony. Twelve other witnesses spoke for environmental groups and energy companies and projects receiving funding from DOE. Additional material for the record from the American Nuclear Energy Council, the Edison Electric Institute, DOE, and the Energy Conservation and Power Subcommittee follows the testimony. (DCK)

4839 **Energy and water development appropriations for Fiscal Year 1984. Hearings before a Subcommittee of the Committee on Appropriations, United States Senate, Ninety-Eighth Congress, First Session on H.R. 3132. Part 2 (pages 585-1312), Department of Energy.** Washington, DC; Government Printing Office (1983). 737p.

Part 2 of the hearing record continues with six days of testimony reviewing the 1984 budgets for DOE, the five federal power marketing administrations, and specific energy and defense research programs. Energy Secretary Hodel gave an overview of the energy situation and the federal role in meeting energy needs when he defended the $11.9 billion budget request. Specific areas of research were presented by agency officials with direct responsibility for research and development. (DCK)

2940 Fossil Fuels

REFER ALSO TO CITATION(S) 4278, 4354, 4355, 4357, 4384, 4385, 4386, 4387, 4388, 4389, 4389, 4396, 4400, 4401, 4785, 4797, 4837

4840 **(TENRAC/EDF—091) Impacts of lignite development in Texas: an environmental primer.** (Espey, Huston and Associates, Inc., Austin, TX (USA)). Aug 1983. 92p. NTIS, PC A05/MF A01. Order Number DE84900409.

Coal and lignite supplied over one-fifth of electrical generation in Texas in 1981. Within the next decade, this proportion will rise to one-third of the State's power, with an increasing portion of the mineral reserves being mined within the State. Mining of coal and lignite will bring new opportunities as well as challenges to Texas and to communities near mining and power generation projects. In addition to the social and economic impacts this development will bring, the mining of these energy resources also has the potential to affect the environment in many ways. Because the extraction of lignite and coal in Texas is generally accomplished through surface mining, there are potential environmental impacts on water resources, wildlife, vegetation, air quality, geology and other resource units. Many of the potentially negative impacts can be prevented or mitigated through procedures required by state and federal legislation. Other lignite and coal development effects are positive. Relatively low cost lignite can contribute to lower energy bills, and the substitution of lignite for western coal represents a substantial stimulus to the state's economy. At the community level, mining and power plant development brings jobs, a stimulus to local businesses, and the potential for growth in the tax base. Rapid growth can also create problems for small communities, of course, particularly in the early construction phases of the projects. This report concentrates on the potential impacts of lignite development, since in Texas, mineral reserves of lignite are much more abundant than those of bituminous coal.

2960 Electric Power

4841 **(DOE/EIA—0226(83/08)) Electric power monthly.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). Aug 1983. 43p. NTIS, PC A03/MF A01 - GPO. Order Number DE84002327.

This document includes comprehensive information about the electric utility industry in the United States. During August 1983, electric generating plants in the United States produced a record breaking 229,472 GWh. Coal accounted for 56.4 percent of all electricity produced, petroleum for 6.5 percent, gas for 14.4 percent, nuclear power for 11.1 percent, hydroelectric power for 11.3 percent, with the remaining 0.3 percent from geothermal, wood, and waste.

4842 **(DOE/EIA—0397(83/2Q)) Electric power quarterly, April-June 1983.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). Sep 1983. 325p. NTIS, PC A14/MF A01 - GPO. Order Number DE84002689.

This document provides electric utilities' plant-level information about the cost, quantity, and quality of fossil fuel receipts, net generation, fuel consumption, and fuel stocks. Data regarding electric utilities' net generation, fuel consumption, and fuel stocks are presented on a plant-by-plant basis. In addition, quantity, cost, and quality of fossil fuel receipts are presented on a plant-by-plant basis.

4843 **(DOE/RG/06371—T1) Analysis of impacts of industrial and commercial time-of-day rates. Final report.** (Hittman Associates, Inc., Rancho Cordova, CA (USA)). Jun 1981. Contract AC01-78RG06371. 11p. NTIS, PC A02/MF A01. Order Number DE84002153.

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A comprehensive analysis was conducted of the effects on large industrial commercial customers of time-of-day rates that have been put into effect recently by several major US electric utilities. With respect to electric utilities, the scope of the study is limited to those utilities with 1977 sales greater than 500 million kWh and which implemented mandatory or voluntary time-of-day rates for any portion of their commercial and industrial customer classes on or before January 1, 1978. With respect to customers, the study considered only commercial and industrial customers with maximum demands of greater than 500 kW. Residential customers who have been put on time-of-day rates were not considered.

4844 **(GAO/RCED—83-170) Analysis of electric utility load forecasting.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 22 Jun 1983. 47p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to the Subcommittee on Energy Conservation and Power Committee on Energy and Commerce, House of Representatives.

The Chairman requested GAO review electric utility load forecasting. He was specificially interested in forecasting methodologies, key variables, state of the art, and how conservation and small decentralized power resources are addressed. This report presents a summary of electric utility load forecasting as currently accomplished by utilities of various sizes. It highlights the many controversies surrounding forecasting and discusses how utilities are attempting to deal with the uncertainty inherent in forecasts of future power demand.

4845 **(P—300-82-006) Cost estimates and cost-forecasting methodologies for selected nonconventional electrical-generation technologies.** Amir, E. (Teknekron Research, Inc., Berkeley, CA (USA). Energy and Environmental Systems Div.). May 1982. 527p. NTIS, PC A23/MF A01. Order Number DE84900212.

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Mutally consistent cost estimates of alternative electricity generating technologies and renewable-resource technologies for use in California were developed. Status summaries, technical descriptions, reference systems, and component cost estimates were prepared for wind, liquid dominated geothermal, industrial cogeneration, fuel cells, and solar thermal electric systems. A costing methodology consistent with those used by the Electric Power Research Institute and the California Energy Commission was developed and documented back to first principles for use in estimating the cost of electricity. The costing methodology considers both the effect of maturity and the great deal of uncertainty inherent in the cost estimates for these developing technologies. Busbar power costs are estimated for each technology in 1980, 1985, 1990, 1992, and 2000.

4846 **(TVA/OGM/IO—83/12) Electricity.** Sims, B. (ed.). (Tennessee Valley Authority, Knoxville (USA). Office of the General Manager). 1983. 188p. Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, TN 37902.

Historical aspects of electricity are reviewed with individual articles on hydroelectric dams, coal-burning power plants, nuclear power plants, electricity distribution, and the energy future. A glossary is included. (PSB)

4847 **1982 rate proposal, Bonneville Power Administration.** *EIS (Environmental Impact Statements);* **6**: No. 6, 8(Jun 1982).

Increasing the wholesale power rates of the Bonneville Power Administration (BPA) is proposed. The BPA service area consists of Washington, Oregon, Idaho, and Montana west of the Continental Divide. BPS also sells surplus power to California. The rate increase would be sufficient to increase the overall revenue of the BPA by 51 percent over the estimated revenue that would be collected under the present rates. The individual increase to specific customer classes would vary. The proposal would incorporate BPA's actual revenue level increases since 1979, the 1982 proposed revenue increase, and anticipated revenue level increases through June 30, 1985. The rate as of June 30, 1985 would be held constant to project revenue levels to the year 2000. The rate schedule would isolate only the consequences of BPA's revenue level increases from 1979 to June 30, 1985. Conservation programs designed for residential, industrial, and commercial consumers could be incorporated into the plan to mitigate the socioeconomic effects of rate increases. Positive and negative impacts of the proposed increases are discussed.

2980 Consumption And Utilization

4848 **(DOE/EI/10085—T2) Technical documentation - residential energy consumption survey: household transportation panel (monthly gasoline purchases and vehicle and household characteristics, June 1979-September 1981).** (Response Analysis Corp., Princeton, NJ (USA)). Oct 1983. Contract AC01-79EI10085. 363p. NTIS, PC A16/MF A01. Order Number DE84002247.

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This survey covered over 8000 households for fuel purchases for their vehicles over a 28-month period. Each household diary covers at least one month of data. The survey was designed to: provide monthly estimates related to residential vehicle and fuel use including gallons consumed, miles driven, number of vehicles in use; provide quick feedback to the government on the extent and severity of fuel shortages; and to create a data set for analysis of fuel consumption at the household level monthly and annually. (PSB)

4849 **(DOE/EI/10085—T3) Residential energy consumption survey: fall-winter 1980-1981, household and utility company surveys, data collection materials.** (Response Analysis Corp., Princeton, NJ (USA)). Sep 1983. Contract AC01-79EI10085. 306p. NTIS, PC A14/MF A01. Order Number DE84002250.

Procedures, questionnaires, and survey results are reported for this nationwide survey on energy use for planning for future supplies (PSB)

4850 **(DOE/EI/10085—T4) Residential energy consumption survey: fall-winter 1981-1982, household and utility company surveys, data collection materials.** (Response Analysis Corp., Princeton, NJ (USA)). Oct 1983. Contract AC01-79EI10085. 267p. NTIS, PC A12/MF A01. Order Number DE84002248.

Procedures, questionnaires, and survey results are included for this nationwide survey on energy use for planning the future supplies. (PSB)

4851 **(DOE/EI/10085—T5) Residential energy consumption survey. Evaluation and review of sample design, April 1980, January 1982, and August 1983.** Steinburg, J. (Response Analysis Corp., Princeton, NJ (USA)). Aug 1983. Contract AC01-79EI10085. 73p. NTIS, PC A04/MF A01. Order Number DE84002246.

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Design objectives are reviewed and data evaluated for the first 3 years. Possible modifications are suggested for methodology and data elements. (PSB)

4852 **(DOE/EIA—0418) Interutility bulk power transactions description, economics, and data.** Serot, D.E.; Cohen, G.; Makens, J.W.; Lawrence, M.S.S. (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). Oct 1983. 103p. NTIS, PC A06/MF A01 - GPO. Order Number DE84002942.

The study describes how bulk power transactions occur, defines categories of bulk power transactions and the market mechanisms that support them, and reviews Federal and State regulation of these transactions. Data on 1980 transactions for 133 investor-owned utilities are analyzed to assess the impact of several factors that influence the conduct of bulk power transactions. The economic analysis of aggregate annual transaction data shows that transactions reflect the relative cost advantage of coal-fired generation over oil- and gas-fired generation. The analysis also shows that, in some regions, economically desirable transactions are constrained by limited physical access to coal-fired capacity. In general, the analysis shows how these transactions are in an important factor in the electric utility industry and may become even more important in the future.

2990 Unconventional Sources And Power Generation

REFER ALSO TO CITATION(S) 4518, 4547, 4834, 5393

4853 **(N—8326180) Geographic information systems for assessing existing and potential bio-energy resources: Their use in determining land use and management options which minimize ecological and landscape impacts in rural areas.** Jackman, A.E.; Fabos, J.G.; Carlozzi, C.C. (Massachusetts Univ., Amherst (USA)). 1982. 13p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. of Energy Resource Management, Vol. 2 p 328-350 (SEE N83-26176 15-43).

A management construct is described which forms part of an overall landscape ecological planning model which has as a principal objective the extension of the traditional descriptive land use mapping capabilities of geographic information systems into land management realms. It is noted that geographic information systems appear to be moving to more comprehensive methods of data handling and storage, such as relational and hierarchical data management systems, and a clear need has simultaneously arisen therefore for planning assessment techniques and methodologies which can actually use such complex levels of data in a systematic, yet flexible and scenario dependent way. The description of mapping method proposed broaches such issues and utilizes a current New England bioenergy scenario, stimulated by the use of hardwoods for household heating purposes established in the post oil crisis era and the increased awareness of the possible landscape and ecological ramifications of the continued increasing use of the resource.

4854 **(N—8326198) Assessment planning and evaluation of renewable energy resources: An interactive computer assisted procedure.** Aston, T.W.; Fabos, J.G.; Macdougall, E.B. (Massachusetts Univ., Amherst (USA)). 1982. 23p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 566-588 (SEE N83-26176 15-43).

Adaptation and derivation were used to develop a procedure for assessing the availability of renewable energy resources on the landscape while simultaneously accounting for the economic, legal, social, and environmental issues required. Done in a step-by-step fashion, the procedure can be used interactively at the computer terminals. Its application in determining the hydroelectricity, biomass, and windpower in a 40,000 acre study area of Western Massachusetts shows that: (1) three existing dam sites are physically capable of being retrofitted for hydropower (2) each of three general areas has a mean annual windspeed exceeding 14 mph and is conductive to windpower and (3) 20% of the total land area consists of prime agricultural biomass while 30% of the area is prime forest biomass land.

30 DIRECT ENERGY CONVERSION

3005 Fuel Cells

4855 **(DOE/CS/10047—T9) Steam reforming of No. 2 fuel oil. Final report.** Cerini, D.J.; Shah, R.D.; Voecks, G.E. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Jul 1977. Contract AT01-79CS10047. 38p. NTIS MF A01. Order Number DE84003652.

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Steam reforming of No. 2 Fuel Oils being investigated as a means of generating hydrogen fo fuel cells. Initial experimenal work has been carried out with No. 2 Diesel Fuel. Baseline tests with naphtha were also conducted. The objective of the study was to study the conversion of the fuel into oxides of carbon as a function of the process parameters. The poisoning effects of sulfur on the nickel catalyst were excluded from the study. The results show that temperatures of 1700 to 1800°F are required to obtain high conversions of No. 2 Diesel Fuel, compared to temperatures of 1300 to 1400°F for naphtha. To suppress soot formation, a minimum steam to carbon (molar) ratio of three is required with temperatures above 1400°F. The impregnated type nickel catalyst was found to be more active than the uniformly mixed catalyst. The best results obtained with Girdler G-90C catalyst with a steam to carbon ratio of 4.6 and 1750°F and at a space velocity of 1400 $hour^{-1}$. The methane leakage under these conditions was less than one half percent of input carbon. It is postulated that at this temperature the sulfur in the fuel is not retained by the catalyst. Long duration tests are required to prove this.

4856 **(DOE/ET/15440—16) Development of molten carbonate fuel cell power plant technology. Quarterly technical progress report No. 16, July 1-September 30, 1983.** (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Oct 1983. Contract AC02-79ET15440. 29p. NTIS, PC A03/MF A01. Order Number DE84003765.

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The overall objective of this program is to develop and verify the design of a prototype molten carbonate fuel cell stack which meets the requirements of a 1990's-competitive, coal-fired, electrical utility central station, or industrial cogeneration power plant. Progress is reported.

4857 **(DOE/IR/10264—T1) Investigate the power generating characteristics of a solid electrolyte galvanic solar energy conversion cell. Final report.** (Scientific Applications, Inc., Oakmont, PA (USA)). 28 Oct 1980. Contract FG01-79IR10264. 83p. NTIS, PC A05/MF A01. Order Number DE84003156.

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This research involved the determination of the feasibility of obtaining electrical power from solid carbon in a solid electrolyte galvanic cell at temperatures as high as 1440°C. Some 130 cell configurations were tested. As expected, difficulty was encountered in forcing carbon to enter into the galvanic reaction. Thus, numerous tests were made with various electrolytes, catalysts and cathode materials. Calcia-stabilized zirconia was found to be stable under these conditions and performed much better than either magnesia or yttria stabilized ZrO_2. A combination of a cathode composed of a praseodymium-cobalt perovskite ($PrCoO_3$) and a nickel wire proved to be the best cathode. This, together with zirconium carbide ($ZrC_{0.88}$) as the catalyst produced the maximum power of any cell configuration. Although this was only 170 milli-watts, it was 6 times the power developed by a cell with a platinum film cathode and no catalyst. Miniaturized cells were made as a porous substrate disc, with a thin plasma flame sprayed film on one side. This disc was sintered into a quartz tube and successfully tested with the perovskite cathode and zirconium carbide, with the same power development per cm^3, as above.

4858 **Simple porous electrode models for molten carbonate fuel cells.** Wilemski, G. (Physical Sciences Incorporated, Andover, MA). *Journal of the Electrochemical Society;* **130**: No. 1, 117-121(Jan 1983). Contract AC02-78ET11322.

Individual porous electrode models for the anode and cathode of a molten carbonate fuel cell are described in this paper. These models are used to calculate local cell overpotential and current density in an integral cell model which predicts overall current density and voltage of scaled-up isothermal and nonisothermal cells. The analysis is based on the thin film cylindrical pore model. In this model all electrochemical activity is assumed to occur on film-covered walls of the larger gas-filled pores. Smaller flooded pores were treated as chemically inert. The principle deficiency of the model, besides the oversimplified pore structure assumed, is the lack of measured values for film areas and thicknesses, forcing these parameters to be treated empirically. The main justification for using this model is pragmatic: it is the simplest model which predicts current densities equal to or greater than those already being measured.

4859 **Molten carbonate fuel cell performance model.** Wolf, T.L.; Wilemski, G. (Physical Sciences Incorporated, Andover, MA). *Journal of the Electrochemical Society;* **130**: No. 1, 48-55(Jan 1983). Contract AC02-78ET11322.

A two-dimensional numerical model is developed to simulate nonisothermal performance of molten carbonate fuel cells. The model takes account of gas stream utilization due to electrochemical reaction, conductive heat transfer between cell hardware and gas streams, energy transfer accompanying mass addition to the bulk streams, convective heat transfer by the bulk streams, and in-plane heat conduction through the cell hardware. Individual porous electrode models are used to predict the local dependence of current density on cell temperature and gas composition. Calculate results are compared with experimental data for 94 cm^2 isothermal cells with crossflow geometry for various fuel and oxidant compositions, total gas pressures, and cell temperatures. Excellent agreement is obtained. Calculated distributions of current density and cell temperature are also presented for 1 m^2 nonisothermal cells for cross-, co-, and counterflow geometries. Current density and cell temperature distributions are found to be highly coupled. Calculated temperature differences on the order of 200 K are observed across the face of a cell operating at maximum load.

3008 Miscellaneous Converters

4860 **Experimental results from a beam direct converter at 100 kV.** Barr, W.L.; Hamilton, G.W.; Moir, R.W. (Lawrence Livermore Laboratory, Livermore, California). *Journal of Fusion Energy;* **2**: No. 2, 131-143(Apr 1982). Contract W-7405-ENG-48.

A direct-energy converter was developed for use on neutral-beam injectors. The purpose of the converter is to raise the efficiency of the injector by recovering the portion of the ion beam not converted to neutrals. In addition to increasing the power efficiency, direct conversion reduces the requirements on power supplies and eases the beam dump problem. The converter was tested at Lawrence Berkeley Laboratory on a reduced-area version of a neutral-beam injector developed for use on the Tokamak Fusion Test Reactor at Princeton. The conversion efficiency of the total ion power was 65 + or - 7% at the beginning of the pulse, decaying to just over 50% by the end of the 0.6-s pulse. Once the electrode surfaces were conditioned, the decay was due to the rise in pressure of only the beam gas and not to outgassing. The direct converter was tested with 1.7 A of hydrogen ions and with 1.5 A of helium ions through the aperture with similar efficiencies. At the midplane through the beam, the line power density was 0.7 MW/m, for comparison with our calculations of slab beams and the prediction of 2-4 MW/m in some reactor studies. Over 98 kV was developed at the ion collector when the beam energy was 100 keV. New electrode material released gas (mostly H_2 and CO) in amounts that exceeded the input of primary gas from the beam. The electrodes were all made of 0.51-mm-thick molybdenum cooled only by radiation. This allowed the heating by the beam to outgas the electrodes and for them to stay hot enough to avoid the reabsorption of gas between shots. By minor redesign of the electrodes, adding cryopanels near the electrodes, and grounding the ion source, these results extrapolate with high confidence to an efficiency of 70-80% at a power density of 2-4 MW/m.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

REFER ALSO TO CITATION(S) 4543, 4913

4861 **(DOE/ER/10098—T2) Comprehensive energy management program hybrid photovoltaic/thermal absorber. Final report.** Kumar, G.N.; Sellers, J.P.; Dybczak, Z.W.; Kar, P.K. (Tuskegee Inst., AL (USA). School of Engineering). Dec 1982. Contract FG05-78ER10098. 278p. NTIS, PC A13/MF A01. Order Number DE84003486.

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This report presents the efforts of research work done on the two-part research program: to improve energy conservation through increased unit and system efficiencies, energy management, and system optimization; and to develop a novel, low-cost hybrid photovoltaic/thermal absorber. Additional objectives of this effort are to increase energy research capability at a minority institution with regional technology transfer potential, to enhance faculty expertise and student energy-training opportunity, and to contribute to the national pool of energy alternatives. To increase the unit and system efficiencies, performance tests were conducted on all the boilers, chillers and other units on campus. Several corrective measures were indicated. After corrective measures were implemented retests were made which showed considerable improvement in their efficiencies and thus considerable savings in energy. A detailed survey of energy use by functions and consumption/demand study has been made. This includes determining spaceheating requirements, hot water requirements, cooling load requirements for each building on campus on an hour-to-hour basis. A detailed computer simulation model of the entire campus has been developed and made operational. Computer codes have been developed to determine the ambient temperature and relative humidity. Development of a computer code for the optimization and energy management studies of the entire system has also been completed. Overall objectives of the pressure stabilized thin-film concentrator/light pipe total energy receiver research program are discussed in light of most recent experience. Descriptions of both the 6 ft and 20 ft diameter concentrators are presented, including new 6 ft diameter experimental data obtained with a square light pipe.

4862 **(DOE/R6/10949—T1) ELDON water heater.** Wood, H.E. (Wood (Harry E.) and Associates, New Orleans, LA (USA)). 18 Jul 1980. Contract FG46-79R610949. 6p. NTIS, PC A02/MF A01. Order Number DE84003534.

Experience with the installation of an ELDON water heater in the TLC Services, Inc. laundry facility is reported. Piping diagram and pictures are included. (MHR)

4863 **(DOE/R6/10953—T1) High-mass, ventilated roof system. Final technical report.** Verdel, T.H. (Verdel (Thomas H.), Oklahoma City, OK (USA)). 2 Oct 1981. Contract FG46-79R610953. 10p. NTIS, PC A02/MF A01. Order Number DE84003548.

The installation and performance of concrete roof tile with air space ventilation beneath it are described. A drawing of the roof system and a cost breakdown of its installation are included. (MHR)

4864 **(DOE/R6/10959—T1) PortaLab manual: low-cost soil-engineering tests for constructing earthen buildings.** Scoggins, H. (Earth Lab Systems, Alamogordo, NM (USA)). Jun 1981. Contract FG46-79R610959. 38p. NTIS, PC A03/MF A01. Order Number DE84003135.

Prospecting for raw materials for adobe and rammed-earth (soil-cement) buildings is described. The importance of sampling material is emphasized and the PortaLab apparatus and procedures are described at length. (MHR)

4865 **(DOE/R6/10965—T1) Low cost earth shelters: embedded vaults. Final report.** Webb, L.D. (Webb (L. Dale), College Station, TX (USA)). Sep 1980. Contract FG46-79R610965. 32p. NTIS, PC A03/MF A01. Order Number DE84003505.

A simple metal vault was constructed and covered layer by layer until approximately a ten foot overburden was developed. Strain gage measurements were made as the overburden was applied. Load reductions on the vault were observed due to allowing it to compress on its base slightly. The vault was layered with hay bales which served as a temporary load bearing structural layer, which upon full loading by the overburden, crushed slightly allowing arching to develop as seen in a reduction of stress in the vault. Various methods of soil stabilization were explored which forced natural arching to occur using reinforced earth.

4866 **(DOE/R6/11000—T1) Sawdust concrete in energy conservation: mobile home energy conservation plus wheelchair gardens. Final report.** (Connors State Coll., Warner, OK (USA)). [nd]. Contract FG46-79R611000. 21p. NTIS, PC A02. Order Number DE84003495.

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Experience with sawdust soaked in whitewash, dried, and used as insulation, concrete aggregate, and in poured plaster insulation board is described. These materials were used in retrofitting an older building for energy conservation and for insulating mobile homes. Some experience in adding fly ash to the concrete is described.

4867 **(DOE/R6/12001—T1) Installation of run-time meters in individual apartments. Final report No. 4.** (Barry (Simmons J.) and Associates, Inc., Baton Rouge, LA (USA)). 17 Jun 1982. Contract FG46-80R612001. 5p. NTIS, PC A02/MF A01. Order Number DE84003232.

Installation of run-time meters in individual apratments of a 343 unit complex to monitor the consumption of energy used by a central heating/cooling system, and to allocate costs on a non-profit basis to each tenant is described.

4868 **(DOE/R6/12010—T1) Water source heat pump. Final report.** Minn, H.S. (Minn (Howard S.), Lake Charles, LA (USA)). 26 May 1982. Contract FG46-80R612010. 7p. NTIS, PC A02/MF A01. Order Number DE84003234.

The performance of the water source heat pump is reported. Modifications are discussed as follows: duct heater, drip cooler, and mixing tank. System schematics and energy consumption are shown. (MHR)

4869 **(DOE/R6/12014—T1) Earth-coupled heat exchange for heat pump.** Braud, H.J.; Klimkowski, H.; Oliver, J. (Louisiana State Univ., Baton Rouge (USA)). 1982. Contract FG46-81R612014. 14p. (CONF-8206179—4). NTIS, PC A02/MF A01. Order Number DE84003433.

From American Society of Agricultural Engineers summer meeting; Madison, WI, USA (27 Jun 1982).

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Experimental values of earth heat transfer rates for both cyclic duty operation and final steady state rate are presented. The main objective of the work was to document the rate at which the earth can absorb heat from the circulating fluid with different temperature levels, duty cycles and heat exchanger designs. A procedure and the necessary information for design of earth-coupled heat exchangers by traditional engineering methods are given also. The procedure is for heat exchanger design in any earth temperature field and choice of casing pipe materials. An example problem is presented to explain the necessary calculations that determine the heat transfer capacity requirement for a heat exchanger and how the operating characteristics of the heat pump must be taken into account.

4870 **(DOE/R6/12014—T2) Water well heat exchange for heat pump space heat/cool and hot water. Quarterly progress report, March 1-June 30, 1982.** Braud, H.J. (Braud (Harry J.), Gonzales, LA (USA)). 30 Jul 1982. Contract FG46-81R612014. 14p. NTIS, PC A02/MF A01. Order Number DE84003430.

The residence is being cooled and provided with domestic hot water entirely by the earth-coupled heat pump system. Installation of the earth-coupled heat exchangers was completed and connected to the water supply system to the heat pumps. A small equipment closet was built under the roof overhang on the rear wall of the residence to house the meters, electric control panel, circulation pump and water flow meters. An instrument module is ordered for a data acquisition system (LSU-owned) that will be used to monitor exact heat exchange rate to earth with the two types (U-bend and concentric pipe) vertical heat exchangers installed at the site.

4871 **(DOE/R6/12025—T1) Low-water use commode waste digester. Final report.** Davidson, W.G. (Soil-crete Solar Co., Navajo Dam, NM (USA)). [nd]. Contract FG46-80R612025. 11p. NTIS, PC A02/MF A01. Order Number DE84003000.

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The low-water use commode waste digester construction has been completed and two of the three chambers have been put to use. One is connected to the commode for continuous feed and one is used as a batch digester. As of this date, neither chamber has produced a usable gas, though both are active and producing.

4872 **(DOE/R6/12031—T1) Development and design of a low speed field modulated generator system. Final report.** Ramakumar, R. (Oklahoma State Univ., Stillwater (USA). School of Electrical and Computer Engineering). Dec 1982. Contract FG46-81R612031. 59p. NTIS, PC A04/MF A01. Order Number DE84003424.

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The primary objective of this project is to develop and design a variable-speed constant-frequency electric power generating system based on the principle of field modulation. The system will operate over a (low) speed range of 1200 to 1800 r/min, and generate constant-frequency 60 Hz utility-grade alternating current for direct use by consumers or for insertion into a utility grid. The rating of the system is to be 10/15 kW, at a constant output voltage of 240/120 V. The design of the system has been completed in sufficient detail and the task of fabrication and testing of an experimental prototype can be undertaken. Some components in the electronics sybsystem can be finalized only after experimentation and fine-tuning of the overall system. In all these cases, ranges of values have been given and no major hurdles are present in initiating the task of fabrication, assembly, and testing of the system.

4873 **(DOE/R6/12039—T1) Geothermal cooling retrofit system. Third quarter report; fourth quarter report.** Farrar, B.R. (Farrar (Blake R.), Norman, OK (USA)). 3 May 1982. Contract FG46-80R612039. 4p. NTIS, PC A02/MF A01. Order Number DE84003425.

Use of ground source air cooling is described. It was found that summer humidity in Oklahoma was too high for good performance of the system. Modifications to the house and addition of an air source heat pump to the ground tubes were discussed. (MHR)

4874 **(DOE/R6/12048—T1) Energy conservation in domestic central air conditioners. Final report.** Kinsey, B.B. (Scientific Services, Austin, TX (USA)). 1 Dec 1982. Contract FG46-80R612048. 18p. NTIS, PC A02/MF A01. Order Number DE84003158.

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A description is given of a system to reduce power demand for domestic central air conditioners by fitting a water-cooled condenser and a timing device. Costs and results are presented. (MHR)

4875 **(DOE/R6/12057—T1) Investigation of heat pump efficiencies using groundwater and/or ground coil in the Gulf Coast region. Final report.** Mei, H.T. (Lamar Univ., Beaumont, TX (USA). Dept. of Mechanical Engineering). 1 Aug 1982. Contract FG46-80R612057. 56p. NTIS, PC A04/MF A01. Order Number DE84003137.

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This project examines the energy efficiencies of five different water source heat pump systems. This is further supported by an

experimental effort in which an existing residence is retrofitted with a heat pump and other energy sources: well water as a heat source/sink, vertical geothermal well as heat source/heat sink/storage, horizontal buried metal and plastic ground coils to use as heat source/heat sink, and a solar assist system. The energy elements are operated individually and in combination configurations to determine performance, and cost effectiveness of the energy alternatives are explored.

4876 **(DOE/R6/12058—T1) Improved structural systems for earth sheltered housing. Structural supplement to the design program.** Behr, R. (Texas Tech Univ., Lubbock (USA). Dept. of Civil Engineering). Oct 1981. Contract FG46-80R612058. 197p. NTIS, PC A09/MF A01. Order Number DE84002428.

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Additional engineering information is provided with regard to the structural analysis and design of thin shell concrete structures. The design program has tentatively demonstrated the overall architectural and marketing feasibility of curved, thin shell structural systems for earth sheltered housing. This supplement will address the structural feasibility question by presenting a complete manual analysis and structural design of an earth sheltered dome/tension ring/wall structural system, and also by presenting the results of a parametric sensitivity study of the dome/ring/wall configuration with respect to variations in span and rise for a three foot soil loading condition. Double curvature dome configurations are emphasized in this structural supplement because their analysis is not extensively addressed in earth sheltered housing literature.

4877 **(DOE/R6/12062—T1) Hill Country Youth Ranch caliche block project. Final technical report.** (Hill Country Youth Ranch, Ingram, TX (USA)). [nd]. Contract FG46-80R612062. 20p. NTIS, PC A02/MF A01. Order Number DE84003155.

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For the past 3 1/2 years Hill Country Youth Ranch has worked with caliche blocks, size 10" x 14" x 4". Different production methods and several different mixes were tried and a stable, attractive building block that can be produced for approximately $.75 was arrived at. A general description of the experiment, procedures, and results of this work are presented. Perhaps the most important addendum to the material already prepared is a breakthrough during the last three months in the screening procedure. This procedure accounts for about 1/3 of the labor cost in caliche blocks. An automated device was built that allows the filling of a hopper with raw caliche and the retrieval of it in the desired powdered form without manual labor. This machine, which cost about $6000, is a shaker and crusher combination. The procedures are outlined.

4878 **(GAO/PLRD—83-46) Improved energy management in the facility design process should reduce operating costs for DOD.** (General Accounting Office, Washington, DC (USA). Procurement, Logistics, and Readiness Div.). 8 Apr 1983. 52p. US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Report to The Secretary of Defense.

Efforts by the Department of Defense to design energy efficient buildings for military use and the need for improved procedures in this regard are discussed. GAO found that: DOD was providing building designers unrealistic energy usage objectives; the services have issued inconsistent energy design guidelines; and the Army and Navy implemented energy conservation requirements differently, inadequately controlled and reviewed designers' submissions, and selected designers without proper attention to their energy conservation expertise.

4879 **(LBL—16644) Energy and housing for the elderly: preliminary observations.** Diamond, R.C. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 19p. (CONF-8310110—1). NTIS, PC A02/MF A01. Order Number DE84003036.

From Conference on families and energy: coping with uncertainty; East Lansing, MI, USA (9 Oct 1983).

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Two recent housing projects for the elderly - one rural, one urban - are examined for how factors relating to design, construction, and occupation affect energy consumption. The study focuses on this population both because the fixed-income elderly are particularly vulnerable to rising energy prices and because little is known about the energy and comfort needs of this group. The approach is interdisciplinary, drawing on the architects, housing authorities, utility companies, and the residents themselves. The goal of the project is to determine what information is needed when and by whom to provide energy-efficient housing for the elderly. The methods used in the study include building energy modeling with the computer program CIRA; interviews with the architects, builders, and managers; measurements of indoor temperatures and outdoor weather conditions; and analysis of utility bills. Also, the author lived at one of the housing projects for two weeks, interviewing sixty residents about their use and knowledge of energy conservation as part pf a general housing questionnaire. Preliminary results from the study point out the importance of studying the context in which architects design buildings - how they obtain, process, use, and discard information on energy. Utility data show how much gas and electricity are used, but say nothing of how this affects comfort and habitability. Because occupant behavior tends to dominate variations in energy use for these projects, studying occupant acitivities has been crucial to understanding the patterns of energy use.

4880 **(LBL—16657) Some technical and behavioral aspects of energy use in a high-rise apartment building.** Lipschutz, R.D.; Diamond, R.C.; Sonderegger, R.C. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 18p. (CONF-8310110—2). NTIS, PC A02/MF A01. Order Number DE84002907.

From Conference on families and energy: coping with uncertainty; East Lansing, MI, USA (9 Oct 1983).

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A study in a 328-unit, 15-story high-rise apartment building in Oakland, California, to investigate energy use patterns in such a structure is reported. A 20 to 1 range in baseload electricity consumption and a 40 to 1 range for space heating in a sample of 207 units were found. Units with an eastern orientation used less electricity for space heating than did those facing other directions. The analysis suggests that some occupants may be using their gas ranges for space heating, although our results are not conclusive. A second major cause of the variations may be differences in occupants' temperature preferences.

4881 **(LBL—16669) Saving energy in occupied buildings: results from the Lawrence Berkeley Laboratory residential data bases.** Goldman, C.A.; Wagner, B.S. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 26p. (CONF-8310110—3). NTIS, PC A03/MF A01. Order Number DE84002912.

From Conference on families and energy: coping with uncertainty; East Lansing, MI, USA (9 Oct 1983).

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This paper summarizes results to date from the residential portion of the Building Energy Use Compilation and Analysis (BECA) project, comprising findings from several hundred studies of new and retrofitted buildings. The following are discussed for both new and retrofitted homes: (1) energy savings and the range of savings for given types of measures; (2) cost and cost-effectiveness of various measures; and (3) methodology. In existing residences, data compiled from roughly 70 retrofit projects, with sample sizes that range from 1 to 33,000 homes, strongly indicate that retrofits often significantly reduce annual space heating energy consumption. But, results are highly variable. The maximum energy savings from individual measures installed in different households are 3 to 7 times greater than the median value. Nineteen conservation programs sponsored by utilities achieved annual space heat savings of 38.5 million Btu at an average investment level of $1050. Twenty-nine of 215 new homes in our BECA-A database have detailed sub-metered data that permits normalization of space heat loads for both indoor temperature and internal gains. In these homes, the standardized heating energy requirement ranges from 10

to 25 kBtu/ft² over various climatic regions, a value that is roughly 50% less than current building practice.

4882 **(ORNL/CON—117) Interactive savings calculations for RCS measures, six case studies.** Stovall, T.K. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 32p. NTIS, PC A03/MF A01. Order Number DE84002982.

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Many Residential Conservation Service (RCS) audits are based, in whole or in part, on the RCS Model Audit. This audit calculates the savings for each measure independently, that is, as if no other conservation actions were taken. This method overestimates the total savings due to a group of measures, and an explanatory warning is given to the customer. Presenting interactive results to consumers would increase the perceived credibility of the audit results by eliminating the need for the warning about uncalculated interactive effects. An increased level of credibility would hopefully lead to an increased level of conservation actions based on the audit results. Because many of the existing RCS audits are based on the RCS Model Audit, six case studies were produced to show that the Model Audit algorithms can be used to produce interactive savings estimates. These six Model Audit case studies, as well as two Computerized Instrumented Residential Audit cases, are presented along with a discussion of the calculation methods used.

4883 **Energy-conservation opportunities in the small industrial plant.** Eckerlin, H.; Boyers, A. Cambridge, MA; The MIT Press (1982). 84p.

Even small industrial plants present opportunities for more efficient energy use. A collection of suggestions and procedures for identifying and evaluating energy-conservation opportunities in such plants is given, and it includes a guide to the establishment of energy-saving programs. Figures and tables are included.

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4884 **(CONF-840116—1) Using an industry coordination meeting in the development of summary information on truck energy efficiency measures.** Bertram, K.M.; Saricks, C.L.; Gregory, E.W. II. (Argonne National Lab., IL (USA)). 1984. Contract W-31-109-ENG-38. 60p. NTIS, PC A04/MF A01. Order Number DE84004624.

From 63. annual meeting of Transportation Research Board; Washington, DC, USA (16 Jan 1984).

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The third project undertaken to develop and distribute compendia of measures for saving transportation fuel is documented. A matrix or chart, of over 60 fuel savings options was developed by ANL, then refined with the assistance of truck industry operators and researchers at an industry coordination meeting in August 1982. The truck meeting consensus that the single most important element in a truck fuel efficiency improvement program is the human element - namely developing a strong motivation to save fuel among truck drivers is highlighted. The number and variety of changes made to the matrix are also delineated, including the addition and deletion of various options, and revisions of fuel savings percentage estimates, payback period estimates, and remarks concerning such items as the advantages, disadvantages, and cautions associated with measures. This demonstrates the considerable research value of using a forum of industry operators and researchers to refine research data intended for practical application.

4885 **(N—8325707) Description of the computations and pilot procedures for planning fuel-conservative descents with a small programmable calculator.** Vicroy, D.D.; Knox, C.E. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). May 1983. 37p. (NASA-TM—85642). NTIS, PC A03/MF A01.

A simplified flight management descent algorithm was developed and programmed on a small programmable calculator. It was designed to aid the pilot in planning and executing a fuel conservative descent to arrive at a metering fix at a time designated by the air traffic control system. The algorithm may also be used for planning fuel conservative descents when time is not a consideration. The descent path was calculated for a constant Mach/airspeed schedule from linear approximations of airplane performance with considerations given for gross weight, wind, and nonstandard temperature effects. The flight management descent algorithm and the vertical performance modeling required for the DC-10 airplane is described.

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REFER ALSO TO CITATION(S) 4567

4886 **(CONF-8110137—5) Chemistry of the recovery of alumina from fly ash.** Kelmers, A.D.; Canon, R.M.; Egan, B.Z.; Felker, L.K.; Gilliam, T.M.; Jones, G.; Owen, G.D.; Seeley, F.G.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). 1981. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01. Order Number DE84003318.

From Symposium on resource recovery and environmental issues of industrial solid wastes; Gatlinburg, TN, USA (28 Oct 1981).

A comprehensive investigation of several methods for the recovery of aluminum from fly ash was carried out. The objective was to investigate and evaluate methods for the recovery of high purity alumina which could be readily substituted in the existing aluminum industry for imported alumina or for alumina derived from imported bauxite. Here, the chemistry of the direct acid leach, Calsinter, and Pressure Digestion-Acid Leach methods is reviewed. Only partial aluminum solubilization (30 to 60%) can be achieved by direct acid leaching of eastern ashes since a portion of the aluminum is in crystalline mullite which is relatively acid insoluble. Of the three acids tested (HCl, H_2SO_4, and HNO_3), HCl proved to be the most effective. Suitable leach conditions for eastern fly ashes were found to be 2 h at reflux temperature. High aluminum solubilization (>90%) from eastern ashes can be obtained by acid leaching, following a basic treatment to chemically alter the mullite. A high temperature sinter with lime or scrubber sludge (Calsinter) can be employed to form anorthite and/or gehlenite, or a pressure digestion reaction with caustic soda (PDAL) can be used to form zeolite X. Following these reactions, the aluminum can be solubilized by acids.

4887 **(DOE/CE/40586—T1) Analysis of a new waste paper defibering and deinking process. Final report.** (Energetics, Inc., Columbia, MD (USA); Resin Research Labs., Inc., Newark, NJ (USA)). Nov 1983. Contract AC01-82CE40586. 105p. NTIS, PC A06/MF A01. Order Number DE84002138.

A new defibering and deinking system was characterized and compared to existing deinking technology to determine potential energy savings. The system consists of two sets of chemical interactions (one for defibering and deinking and one for separation of ink from fiber in suspension) using proprietary chemicals and a process sequence intended to enhance the process chemistry. Front end pulping and washing, which defibers the waste paper and removes contaminants other than ink, is followed by flotation for ink removal and final washing and thickening. Claims for the system include: the capability to remove problem inks, coatings, pigments, etc. other systems cannot; energy conservation due to the use of fewer prime pieces of equipment and more energy efficient ink flotation equipment; equipment cost savings due to the use of fewer prime equipment pieces; and operating cost savings from the use of lower cost paper furnishes. Preliminary findings based on laboratory and pilot testing, and available cost and energy consumption data show these claims to be reasonable. Therefore, full-scale testing of the RRL system is recommended to validate process performance estimates.

4888 **(DOE/CS/40294—T1) Development and demonstration of a spiral-wound thin-film composite membrane system for the economical production of oxygen-enriched air, Phases I, II and III. Final report, October 1, 1979-December 31, 1982.** Epperson, B.J.; Burnett, L.J. (UOP, Inc., San Diego, CA (USA). Fluid Systems Div.). Nov 1983. Contract AC01-79CS40294. 211p. NTIS, PC A10/MF A01. Order Number DE84002918.

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A spiral-wound membrane oxygen-enrichment system, designed in standard unit form, was assembled using membrane of current technology but in scaled-up dimensions. The system was operated on a radiant-tube annealing furnace to demonstrate that membrane oxygen enrichment is feasible in commercially interesting quantities. In a parallel development, the membrane was improved by decreasing the thickness of the separation barrier and thereby increasing the flux of oxygen-enriched air. The increase in gas flux significantly lowered the cost of oxygen in industrial quantities. In a similar development the spiral-wound element construction was improved by increasing the element diameter which increases membrane area and reduces capital costs, and by reducing internal pressure drops which increase element efficiency. The current oxygen-enrichment system was evaluated and recommendations for an improved system were made. Finally, novel polymers for use in a membrane oxygen-enrichment system will be investigated. Candidate polymers will be evaluated in terms of several criteria including their film forming characteristics, their gas transport properties, their thermal stability and their compatibility with thin-film composite membrane technology.

4889 **(DOE/CS/40341—T4) Feasibility of black liquor gasification in combined cycle cogeneration. Final report, Phase I.** Kelleher, E.G. (Saint Regis Paper Co., West Nyack, NY (USA). Technical Operations Div.). 30 Jun 1983. Contract AC05-80CS40341. 225p. NTIS, PC A10/MF A01. Order Number DE84002936.

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A small-scale test program of 65% solids black liquor gasification was conducted in the bench-scale molten salt gasifier. Nine tests were performed using both air and oxygen as the oxidant. The black liquor gasified readily and the product gas had a dry-basis heating value of 70 Btu/scf with air and about 250 Btu/scf with oxygen. These values were almost identical to values predicted on the basis of thermodynamic equilibrium in the gas phase, indicating that the system had achieved near-equilibrium. However, the reduction of the melt to sodium sulfide was generally low. An independent research program aimed at improving the performance of air-blown black liquor gasification was conducted. That work resulted in a modified gasifier system design which increased the off-gas heating value to 120 Btu/scf and the reduction of the melt to over 95%. This was an improvement that would potentially allow use of the scrubbed product gas as a feed to a combustion gas turbine without prior enrichment.

4890 **(DOE/CS/40453—T1) Conservation of energy in monoammonium and diammonium phosphate fertilizer granulation plants. Final progress report No. 12.** (National Fertilizer Development Center, Muscle Shoals, AL (USA)). Sep 1983. Contract AI01-80CS40453. 34p. NTIS, PC A03/MF A01. Order Number DE84002244.

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Work done during the last three years to further commercialize pipe-cross reactor (PCR) technology in the production of granular homogeneous NPKS, monoammonium phosphate (MAP), and diammonium phosphate (DAP) fertilizers is summarized. The theory of granulation, the energy savings when replacing conventional ammoniation-granulation with PCR melt granulation, investment cost and payback, etc. are discussed in detail. (MHR)

4891 **(DOE/ID/12236—T1) Development by surface treatment of a high-operating temperature flue gas recuperator. Final report, July 1981-June 1983.** Kindlimann, L.E. (AiResearch Mfg. Co., Torrance, CA (USA)). 25 Aug 1983. Contract AC07-81ID12236. 127p. NTIS, PC A07/MF A01. Order Number DE84003581.

A user survey indicated that a significant number of furnaces having the potential for recuperation operate in the 1500° to 1800°F temperature range, for which suitable low-cost heat exchanger materials are not available. A literature survey on use of coatings to extend the service temperature capability of low-cost materials such as steels and lower grade stainless steels showed that diffusion aluminide coating from the gaseous phase (i.e., chemical vapor deposition) was the most promising approach. The program plan featured comparison of vendor capabilities using coupons, followed by coating small plate-fin and tubular heat exchanger segments. Most testing was conducted in air at 1600° to 1800°F; a few tests were conducted in sea salt-contminated air at 1600°F and in SO_2-contaminated air at 1800°F. Three coating vendors were selected to aluminize small coupons for oxidation testing. The samples of 409 stainless steel were coated over one-half the area on each side with Ni-Cr-Si-B filler metal per AMS 4777 (or AWS BNi-2). The same filler metal was used to join together pieces of 0.009-in. Fe-Ti(IF) to achieve a thickness comparable to the other three materials (0.015 to 0.020 in.). With the exception of 409/4777 tested in air at 1800°F, at least one coupon specimen of each material lasted through the 5000-h test period in plain air at either 1600° or 1800°F. The brazed 409 developed extensive oxidation at the braze-to-parent metal runout line (halfway up the specimen), which then progressed into the 409. Conversely, in the 0.5 percent SO_2 test, the nickel-based 4777 braze was attacked preferentially. Modified coatings and materials for application to brazed construction were also tested.

4892 **(DOE/OR/20808—1) Ethanol production utilizing waste heat. Phart I. Project definition and preliminary design. Final report.** (Renewable Energy, Inc., Paducah, KY (USA); Vulcan-Cincinnati, Inc., OH (USA); Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA); Mechanical Technology, Inc., Latham, NY (USA); Kentucky Dept. of Energy, Lexington (USA)). 30 Sep 1982. Contract FG05-81OR20808. 186p. NTIS, PC A09/MF A01. Order Number DE84003888.

A comprehensive evaluation of the utilization of available waste heat and agricultural feed-stocks for the manufacture of fuel-grade ethanol was completed. The results of the first phase of a four-phase program for the commercialization of a 20-million gal/yr ethanol plant at a site adjacent to the US Department of Energy Gaseous Diffusion Plant (GDP) in Paducah, Kentucky are presented.

4893 **(DOE/R6/12005—T1) Natural farming in Louisiana. Final technical report.** Hair, M. (Hair (Michael), Lafayette, LA (USA)). 31 Dec 1981. Contract FG46-80R612005. 48p. NTIS, PC A03/MF A01. Order Number DE84003117.

This project represents the beginning of an attempt to adapt radically different natural farming techniques of growing rice and winter grain developed in Japan to the Gulf Coast of Louisiana. Choosing a possible set of farming practices and combination of crops appropriate to this area was the first step as the outlines of a complete yearly cycle of rice, wheat, and clover culture without mechanical cultivation or use of chemicals was formulated. A theoretical model of such a natural commercial system was constructed and assigned parameters of labor, energy and money inputs and outputs that would make it potentially competitive with present practices. In order to see whether the chosen set of practices could in fact produce acceptable yields of rice, experimental plots were constructed and provided with irrigation and drainage facilities. Initially winter crops were planted conventionally, organic mulch and nutrients were supplied, and wheat was harvested in the spring. Rice was planted no-till, irrigated, weeded and harvested and finally, winter crops were planted no-till for the next year. Each component of the yearly cycle was observed and evaluated as it was being put into practice, and modifications of those components that did not perform well were suggested. Preliminary data that will indicate the possibilities and limitations of the method were recorded.

4894 **(DOE/R6/12006—T1) Microbially fixed nitrogen as plant fertilizer. Final report.** Wilson, T.E. (University of Southwestern Louisiana, Lafayette (USA)). 1981. Contract FG46-80R612006. 33p. NTIS, PC A03/MF A01. Order Number DE84003230.

On the assumption that biosynthesized materials would be biodegradable, we considered applying waste to soil where the activity of soil microorganisms could provide an effective and safe method of disposal. Some preliminary work had shown that the nitrogenous compounds in Single Cell Protein waste would be converted to ammonia, nitrite and nitrate by soil microbes. Therefore, the waste might contribute to plant nutrition. A Memphis Silt Loam was used in soil columns and a soil bed. Waste was applied

to both, and samples from each were analyzed by standardized methods. Soil was packed into sectional columns constructed from 4 inch PVC pipe. The sectional arrangement permitted material introduced at the top to pass on through to lower levels. Also, soluble materials in the upper sections would be washed down to lower levels providing some difference in nutritional environment. Liquid samples were collected from the drain of each section. Proteinaceous material was adsorbed to the soil. This is indicated by the lower concentrations in the bottom part of the columns at the time of initial sampling. Continued application of waste caused a buildup of proteinaceous material throughout the column.

4895 **(DOE/R6/12012—T1) Reduction of fertilizer nitrogen requirement by plant growth factors. Final progress report.** Wilson, T.E. (University of Southwestern Louisiana, Lafayette (USA). Dept. of Microbiology). [nd]. Contract FG46-81R612012. 23p. NTIS, PC A02/MF A01. Order Number DE84003429.

Results obtained from plant growth experiments are presented. The effects of auxins, commercial fertilizer and Single Cell Protein waste, alone and in various combinations, were measured. The tomato plants used were obtained by germinating seeds and allowing them to grow to approximately three inches in height in sterilized potting soil. Plants of uniform size were transplanted to gallon size pots containing sterilized, mineral balanced, nitrogen deficient potting material. Appropriate control and test materials were added. Moisture and temperature were controlled in the greenhouse. Plant growth, as measured by height of stem, was reasonable when plants were supplied with SCP material although not as good as when commercial fertilizer was used. A slight additive effect was noted with some combinations of SCP material and fertilizer. Minimal concentrations of commercial fertilizer were required for the development of maximum leaf size and in its absence leaf size was reduced slightly. Combinations of SCP waste and fertilizer also resulted in slightly reduce leaf size, suggesting some inhibitory effect.

4896 **(DOE/R6/12055—T1) Waste oil recycling concept development project.** (Community Development Corp., Brownsville, TX (USA)). [nd]. Contract FG46-80R612055. 75p. NTIS, PC A04/MF A01. Order Number DE84003145.

A long range project for recycling used lubricating oil in extreme south Texas is described. The amount of waste oil available for collection was surveyed. Of the businesses contacted, 62% expressed a willingness to participate in a collection program. Current disposal methods for waste oil are covered as well as attitudes toward recycled oil. (MHR)

4897 **(DOE/R6/12078—T1) Energy management and savings by management of steam flow. Final technical report.** (Electronic Flo-Meters, Inc., Dallas, TX (USA)). 24 Feb 1983. Contract FG46-81R612078. 4p. NTIS, PC A02/MF A01. Order Number DE84001207.

The development of hardware to measure and control steam usage for improved energy management is described. When the grant expired hardware development had not been completed. Numerous turbine meter designs were fabricated and tested; a high temperature variable reluctance sensor (pickup) was designed and tested; a special insertion mechanism for safe operation in steam lines was designed; and a companion indicating and control unit design was begun.

4898 **(N—8326155) Proceedings of the National Conference on Energy Resource Management. Volume 1: Techniques, Procedures and Data Bases.** Brumfield, J.O.; Schiffman, Y.M. (Marshall Univ., Huntington, WV (USA)). 1982. 306p. (E—83-10335; NASA-CP—2261-VOL-1; CONF-820972—VOL.1). NTIS, PC A14/MF A01.

From National conference on energy resource management; Baltimore, MD, USA (9 Sep 1982).

Topics dealing with the integration of remotely sensed data with geographic information system for application in energy resources management are discussed. Associated remote sensing and image analysis techniques are also addressed. For individual titles, see N83-26156 through N83-26175.

4899 **(N—8326176) Proceedings of the National Conference on Energy Resource Management. Volume 2: Applications.** Brumfield, J.O.; Schiffman, Y.M. (Marshall Univ., Huntington, WV (USA)). 1982. 415p. (E—83-10336; NASA-CP—2261-VOL.2; CONF-820972—VOL.2). NTIS, PC A18/MF A01.

From National conference on energy resource management; Baltimore, MD, USA (9 Sep 1982).

Subject areas related to the integration of remotely sensed data with geographic information systems for application in energy resource management are covered. The current trends and advances in the application of these systems to a number of energy concerns are addressed. For individual titles, see N83-26177 through N83-26200.

4900 **(ORAU/IEA—83-9(M)) Electric steelmaking: recent trends and future constraints.** Burwell, C.C. (Oak Ridge Associated Universities, Inc., TN (USA)). Oct 1983. Contract AC05-76OR00033. 49p. NTIS, PC A03/MF A01. Order Number DE84002482.

The growth of electric steelmaking in recent years is reviewed. Initially electric melting of surplus scrap complmented the shift from the use of the open hearth process to the more productive basic oxygen process with its more limited capability to remelt scrap. More recently, because of high production and energy efficiency characteristics, production in electric mills continued to grow even as production in basic oxygen furnaces declined. As a result, there is an increasing use of old scrap in steel products. The national inventory of scrap is considered, and processing technologies needed to improve scrap quality are discussed.

4901 **(TENRAC/EDF—099) Multifunction moving truss system for water and energy conservation. Final report.** Lyle, W.M. (Texas Agricultural Experiment Station, College Station (USA)). 19 Aug 1983. 29p. NTIS, PC A03/MF A01. Order Number DE84900435.

A multifunction irrigation system has been designed and developed which is capable of carrying out numerous functions in addition to applying irrigation water. Many of the functions of the moving truss system will include chemical application for the express purpose of reducing plant water stress by decreasing water loss from the soils and plants after irrigation. Its capability also includes precise application of practically all agricultural chemicals currently used for reduction of environmental plant stress. It is anticipated that the multifunction system can eliminate the use of high horsepower tractors after the crop is planted. The dual application of several chemicals at the time of irrigation, or as a separate operation, has the potential to greatly reduce energy consumption for farming operations and also the capital investment for much of the conventional spray and tillage equipment.

4902 **Case studies.** Gyftopovlos, E.P. (ed.). Cambridge, MA; The MIT Press (1982). 100p.

Fourteen actual energy-conservation projects are discussed. Each case study states a problem, considers possible solutions, and reports on the solution that was actually selected. The reports are based on interviews with the engineers involved.

4903 **Efficient allocation of steam.** Cho, C.H. Cambridge, MA; The MIT Press (1982). 31p.

Opportunities for saving fuel in the generation and distribution of industrial steam are presented. Figures and tables are included.

4904 **Energy-conservation opportunities in the chemical industry.** Furbush, S.A. Cambridge, MA; The MIT Press (1982). 121p.

The chemical industry has always been energy-conscious because energy has always been an important cost factor in chemical processes. The many energy-conservation techniques and designs developed for this industry over the years are summarized in manual 14. Figures, tables, and unit self-tests for the reader are included.

4905 **Conserving energy in distillation.** Mix, T.W.; Dweck, J.S. Cambridge, MA; The MIT Press (1982). 104p.

Separation processes are used throughout industry, either for obtaining specific products out of mixtures, for recovering valuable components from waste streams, or for purifying polluting effluent. They usually consume large amounts of energy. Selecting the right separation process for the purpose and optimizing the design can save energy and money while improving product yield and quality. Figures, tables, and unit self-tests for the reader are included.

4906 **Conserving energy in refrigeration.** Furgerson, W.F. Cambridge, MA; The MIT Press (1982). 129p.

Refrigeration systems, including thermodynamic cycles, equipment, energy-saving techniques, and good maintenance practices, are discussed. Figures, tables, and unit self-tests for the reader are included.

4907 **Control systems that save energy.** Shinskey, F.G. Cambridge, MA; The MIT Press (1982). 51p.

The usefulness of controls is exemplified by applications of steam, refrigeration, and distillation processes. Controls are an effective and inexpensive means for reducing fuel consumption and for improving the quality and the yield of products. Definitions, examples, tables, and self-tests are included.

4908 **Thermodynamic efficiency of chemical processes.** Seader, J.D. Cambridge, MA; The MIT Press (1982). 72p.

The efficiency of chemical processes in terms of thermodynamic availability is discussed. Availability flow in a process is obtained by combining the energy and entropy balances–that is, by using both the first and second laws of thermodynamics. The manual provides an almost absolute measure of the margin for improving fuel use, pinpoints the most wasteful or irreversible steps in a process, and accounts for the quality as well as the quantity of energy. Figures, tables, and self-tests are included.

4909 **Synthesizing networks of heat exchangers.** Stephanopoulos, G. Cambridge, MA; The MIT Press (1982). 120p.

The use of heat exchangers to couple hot and cold waste streams in a chemical plant can save energy by reducing the heating and cooling requirements. The theoretical, practical, and economic issues involved in such couplings are often difficult to analyze. As this manual shows, a number of heuristic guidelines can be used to simplify the analysis and to obtain good designs. Tables, figures, and unit tests for the reader are included.

3206 Municipalities And Community Systems

REFER ALSO TO CITATION(S) 4509, 4567, 4871

4910 **(CONF-831151—1) External combustion: an alternative to RDF.** Helt, J.E. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 22p. NTIS, PC A02/MF A01. Order Number DE84003580.

From State-of-the-art and emerging technologies: a waste-to-energy workshop; Chicago, IL, USA (28 Nov 1983).

The concept of using an external combustor integrated into an existing boiler plant and the manner in which this concept differs from other energy from municipal waste (EMW) thermal concepts (i.e., mass burning, dedicated refuse-derived fuel (RDF) combustion, and RDF cofiring) is discussed. Mass and energy balances are given for five representative cases of the external combustor concept. Technical issues are identified and discussed and the need for additional work is highlighted.

4911 **(DOE/R6/10985—T1) Lufkin worm farm. Final technical report.** (Lufkin, City of, TX (USA)). [nd]. Contract FG46-79R610985. 7p. NTIS, PC A02/MF A01. Order Number DE84003504.

The purpose of this project was to demonstrate and document municipal sludge disposal by vermiconposting. A description of the physical facilities, the characteristics and performance of the materials utilized, findings, and an evaluation of the project are included. (DMC)

4912 **Removal of nutrients and heavy metals from anaerobic waste by aerobiological treatment.** Farooq, S. (Univ. of Petroleum and Minerals, Dhahran, Saudi Arabia); Gabriel, P.F. *Environment International;* **9**: No. 1, 69-73(1983).

This study was conducted to investigate the effectiveness of aerobic biological treatment in removal of nitrogen, phosphorous, and heavy metals from a unique anaerobic liquid waste, produced at a solid waste-to-methane anaerobic digestion facility. Laboratory scale continuous flow activated sludge reactors were employed in this study. The liquid waste has moderate BOD/COD ratio with BOD concentration of 1300 mg/L and high concentration of essential nutrients, making the liquid waste biologically treatable. Results showed that aerobic biological treatment can remove nitrogen and phosphorous on the order of 85%. Metal removal efficiencies vary widely for 11 metals studied in this investigation.

3209 Education And Public Relations

REFER ALSO TO CITATION(S) 4786

4913 **(DOE/R6/12080—T1) Educational demonstration program using draft detector to locate air infiltration. Final report.** (Travis County Extension Energy Committee, Austin, TX (USA)). 30 Sep 1982. Contract FG46-81R612080. 121p. NTIS, PC A06/MF A01. Order Number DE83017947.

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A program of education in air infiltration and weatherization is presented. Materials use and drawings of an air leak detector are included. Advertising materials used are also included. (MHR)

4914 **(ORAU—215) Faculty development projects in energy education: an assessment of 1982 summer workshops.** Anderson, A.P. (Oak Ridge Associated Universities, Inc., TN (USA)). Sep 1983. Contract AC05-76OR00033. 31p. NTIS, PC A03/MF A01. Order Number DE84002904.

The Department of Energy Faculty Development Projects in Energy Education were designed to inform elementary and high school teachers about energy so they could introduce students to energy concepts and facts. The program was composed of workshops held at universities for, on average, 2 weeks during the summer. Based on evaluations by the participants, this report assesses 42 of the 55 workshops funded in 1982. It describes those activities that were rated most useful and motivating and the participants' reactions to content and level of information presented. Differences are noted between elementary and secondary teachers, between participants attending workshops on specific topics, and between science and nonscience teachers.

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

3301 Internal Combustion Engines

4915 **(DOE/CE—0027/1) Fourth annual report to Congress on the Automotive Technology Development Program.** (USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC. Office of Vehicle and Engine Research and Development). Nov 1983. 21p. NTIS, PC A02/MF A01. Order Number DE84002148.

Program implementation and management are described. The status of conventional power-train technology is described with respect to uniform charge reciprocating Otto engine, stratified charge reciprocating Otto engine, rotary Otto engine, diesel engine, and transmissions. The three tasks of the Automotive Technology Development Program are discussed as follows; automotive gas turbine project, automotive Stirling engine development project, and the heavy duty transport technology project.

4916 **(N—8326986) Representations of combustion in computer models of spark ignition.** Spalding, D.B. (Imperial Coll. of Science and Technology, London (UK)). Nov 1982. 12p. (CFD—82/18). NTIS, PC A02/MF A01.

Calculation of rates of combustion in turbulent gases is discussed, and a predictive scheme is proposed which builds upon the analogy between turbulent combustion and two-phase flows, characterized by patchiness: sharp temperature (and concentration) differences in the former correspond to discontinuities of density and other properties in the latter. Applications to a one dimensional unsteady flame and to a two dimensional steady one are described. It is suggested that the proposed two-fluid theory can be developed to predict such phenomena quantitatively.

4917 (NZERDC—91) **Technical aspects of CNG.** Stephenson, J.; Jones, K. (New Zealand Energy Research and Development Committee, Auckland. Liquid Fuels Trust Board). Jul 1983. 95p. NTIS (US Sales Only), PC A05/MF A01. Order Number DE84900367.

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Five papers are included. A separate abstract was prepared for each one. (MHR)

4918 (NZERDC—91, pp 6p, Paper 1) **Volumetric efficiency of engines using liquid and gaseous fuels.** Stephenson, J. (Univ. of Auckland, New Zealand). Jul 1983. NTIS (US Sales Only), PC A05/MF A01.

In Technical aspects of CNG.

Of the various criteria that are used to judge the success of the conversion of a petrol engine to CNG, the loss in power at wide open throttle (WOT) usually ranks high. The two principal causes of this loss are discussed here. The least avoidable one is the replacement of some of the air needed for combustion by the gaseous fuel. Another effect is the decrease in engine air flow that may be caused by obstructions in the air induction system. These may stem from installation of gas control or mixing equipment; the loss that results can be minimized by careful design. In the petrol mode, the volume of the fuel vapour in the air induced into the cylinder is small - usually less than 2% of the total flow. With gaseous fuels, the gas volume is of the order of 10%; this gas replaces air needed to provide combustion oxygen, and the amount of fuel that can be burnt in one cylinder charge is reduced.

4919 (NZERDC—91, pp 34p, Paper 2) **Facilities and procedures for CNG testing at the University of Auckland.** Jones, K.; Stephenson, J. (Univ. of Auckland, New Zealand). Jul 1983. NTIS (US Sales Only), PC A05/MF A01.

In Technical aspects of CNG.

To assist in the implementation of CNG in New Zealand facilities have been established at the University of Auckland for the testing of CNG fueled engines and vehicles and CNG conversion systems. The development and specification of the facilities are described. Details of typical engine and chassis dynamometer test procedures are included. Two engine dynamometers are available, capable of accepting spark engines of up to 225 bhp (168 kW) and diesel engines of up to 400 bhp (298 kW). Instrumentation is available for the measurement of fuel and air consumption, exhaust emissions, temperatures and pressures. Specialized fuel consumption equipment for CNG has been constructed. A chassis dynamometer facility has been developed for vehicle testing. Power and fuel consumption testing, both steady state and drive cycle, can be conducted on vehicles with power outputs of up to 100 kW. An air flow rig has been constructed to enable the detailed evaluation of CNG conversion kits to be carried out, either as individual components or as complete systems, without requiring an engine or vehicle.

4920 (NZERDC—91, pp 14p, Paper 3) **Carbon monoxide exhaust emissions and the CNG engine - relationships between power, fuel consumption and CO emissions.** Jones, K.; Stephenson, J. (Univ. of Auckland, New Zealand). Jul 1983. NTIS (US Sales Only), PC A05/MF A01.

In Technical aspects of CNG.

The level of carbon monoxide (CO) exhaust emissions produced by an automotive spark ignition engine is related in a well defined manner to the fuel-air ratio. It is therefore possible, in the absence of more sophisticated equipment, to use a CO exhaust emissions analyzer as an indicator of the relative (but not absolute) fuel economy of an engine. The theory of the formation of CO and its relationship to fuel-air ratio are reviewed. A description is given of a typical Non Dispersive Infrared (NDIR) analyzer of the type used to measure the level of CO in an engine exhaust. In commercial multicylinder S.I. engines inadequate preparation and poor distribution of the fuel-air mixture can lead to high CO levels. The reasons for this are discussed with reference to both petrol and CNG powered engines. To investigate what increasing CO levels can mean in relation to fuel consumption, a CNG powered 4-cylinder 2.3 litre S.I. engine was tested on an engine dynamometer under full and part throttle conditions. It was observed that, for both conditions, a variation in CO level from 0 to 4% corresponded to a variation of about 30% in fuel consumption.

4921 (NZERDC—91, pp 19p, Paper 4) **Ignition timing and the performance of a dual fuel CNG/petrol engine.** Jones, K.; Stephenson, J. (Univ. of Auckland, New Zealand). Jul 1983. NTIS (US Sales Only), PC A05/MF A01.

In Technical aspects of CNG.

To obtain optimum performance from the automotive spark ignition engine it is necessary to vary the ignition timing according to load and speed conditions. The reasons for the variable timing and the implications for the operation of a dual fuel petrol/CNG engine are reviewed. A 2.3 litre 4 cylinder automotive petrol engine was run on CNG and the effects of various ignition timing curves on engine performance were studied. It was observed that, using the static ignition timing and distributor advance curve specified for petrol, the full load power on CNG was between 16% and 36% lower than on petrol. By optimising the ignition timing for best full load power on CNG the difference in power between petrol and CNG was reduced to an average of 12% between 2000 and 5000 rev/min. By optimizing the ignition timing for best throttle response at part load conditions, improvements of up to 10% were obtained in fuel consumption.

4922 (NZERDC—91, pp 19p, Paper 5) **Ignition system performance and requirements for dual fuel CNG/petrol operation.** Jones, K. (Univ. of Auckland, New Zealand). Jul 1983. NTIS (US Sales Only), PC A05/MF A01.

In Technical aspects of CNG.

This report deals with the ignition system and spark plug requirements and performance for dual fuel CNG/petrol operation in automobile engines. In the investigation the relationships between the requirements of the ignition system and spark plugs and engine variables such as load, speed, fuel-air ratio etc., were studied. Tests were carried out on two typical 4 cylinder engines to measure voltage requirements and spark plug temperatures over a range of operating conditions. Conclusions are drawn as to the differences in operational requirements of ignition system components with CNG and petrol and some recommendations are given with regard to spark plug specification.

3302 External Combustion Engines

REFER ALSO TO CITATION(S) 4915

3303 Electric-powered Systems

4923 (CONF-831189—2) **Modeling the effects of electric vehicle demand on mineral prices and flows.** Macal, C.M.; Hill, L.G. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 29p. NTIS, PC A03/MF A01. Order Number DE84003553.

From ORSA/TIMS joint national meeting; Orlando, FL, USA (7 Nov 1983).

A critical question regarding the future commercialization of electric vehicles (EVs) powered by nickel-zinc and lead-acid batteries is their impact on the prices and sources of supply for nickel, lead, zinc, and cobalt. This study examines the effects of EV commercialization on the prices and supply sources of the these minerals for different EV commercialization scenarios. Results indicate that at EV production rates of more than 1 million per year, nontraditional and unstable suppliers including Africa and the USSR increase sales of nickel to the US although prices are not significantly increased. Lead prices are not significantly increased due to EV commercialization and the US and Canada supply most of the EV lead ore demand. Similar results hold for the case of zinc. Under competitive market assumptions, Africa increases its output

of cobalt with little increase in the real price of cobalt. The most significant parameter affecting metal prices and supply sources is the particular annual EV production rate.

4924 **(TVA/OP/EDT—83/36) Automatic vehicle record for electric vehicles. Research Project 1136-18.** Reese, R.W. (Tennessee Valley Authority, Chattanooga (USA). Div. of Energy Demonstrations and Technology). Sep 1983. 23p. NTIS, PC A02/MF A01. Order Number DE84900360.

This report contains specification requirements for the Automatic Vehicle Record (AVR), a data logging device for electric vehicles (EVs). These specifications were developed under the AVR work task of the Electric Power Research Institute/Tennessee Valley Authority Phase II EV Project. Detailed requirements for the AVR are presented along with recommendations for device construction and operation.

4925 **Zinc-bromine battery design for electric vehicles.** Bellows, R.J.; Einstein, H.; Grimes, P.; Kantner, E.; Malachesky, P.; Newby, K. (Engineering Research Center, Exxon Research Engineering Center, 1900 E. Linden Ave., Linden, NJ 07036). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Vehicular Technology;* **32**: No. 1, 26-32(Feb 1983).

Design projections for zinc-bromine batteries are attractive for electric vehicle applications in terms of low manufacturing costs ($28/kWh) and good performance characteristics. Zinc-bromine battery projections (60-80 Wh/kg, 130-200 W/kg) compare favorably to both current lead acid batteries and proposed advanced battery candidates. The performance of recently developed battery components with 1200 cm^2 electrodes in a 120V, 10 kWh module is described. Similarly constructed smaller scale (600 cm^2) components have shown lifetimes exceeding 400 cycles and the ability to follow both regenerative braking (J227aD) and random cycling regimes. Initial dynamometer evaluations of full scale 20 kWh batteries is expected in early 1984.

4926 **Advanced vehicle system concepts.** Hardy, K.S.; Langendoen, J.M. (Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Vehicular Technology;* **32**: No. 1, 51-60(Feb 1983).

Various nonpetroleum vehicle system concepts for passenger vehicles in the 1990's are being considered as part of the Advanced Vehicle (AV) Assessment at the Jet Propulsion Laboratory. The vehicle system and subsystem performance requirements, the projected characteristics of mature subsystem candidates, and promising systems are presented. The system candidates include electric and hybrid vehicles powered by electricity with or without a nonpetroleum power source. The subsystem candidates include batteries (aqueousmobile, flow, high-temperature, and metal-air), fuel cells (phosphoric acid, advanced acids, and solid polymer electrolyte), nonpetroleum heat engines, advanced dc and ac propulsion components, powerpeaking devices, and transmissions.

3304 Hybrid Systems

REFER ALSO TO CITATION(S) 4926

4927 **(DOE/R6/12041—T1) Human/electric hybrid vehicle. Final report.** Thomas, G.R. (Thomas (G. Richard), Stillwater, OK (USA)). 16 Mar 1982. Contract FG46-80R612041. 7p. NTIS, PC A02/MF A01. Order Number DE84003507.

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Demonstrations of the electric-assisted pedal vehicle are described. Newspaper photos are included. (MHR)

3306 Vehicle Design Factors

4928 **(DOE/CS/54231—T1) Evaluation of advanced automobile transmissions. Final report, May 1978-February 1981.** Hull, R.W.; Coon, C.W. Jr. (Southwest Research Inst., San Antonio, TX (USA)). 1981. Contract AI01-78CS54231. 112p. NTIS MF A01. Order Number DE84002434.

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Two advanced design transmissions, one now in production (the Ford integral overdrive) and the other (Orshansky continuously variable) in prototype state of development, were evaluated to determine the increase in fuel economy achievable through the use of a transmission that would provide an improved engine speed/load relationship. The EPA Federal Test Procedure was used for the fuel consumption and emissions measurements. Ford Fairmont test cars, powered by a 302 CID engine, showed 13.8 percent and 17.6 percent increases in mileage for the Ford integral overdrive (FIOD) and the Orshansky continuously variable transmission (CVT) respectively when compared with the baseline C-4 transmission. While achieving the fuel economy gains, emissions increased slightly with the FIOD transmission and were lower (measured in a different car with modified engine) for the CVT equipped car. When tested using light truck inertia loadings, the FIOD continued to show 7 to 8 percent fuel economy improvements with no trend toward higher exhaust emissions. A production lead time for the CVT was estimated to be 4 to 4-1/2 years. Capital investment costs were estimated to be $261 million for the CVT and the incremental cost increase to the consumer was estimated to be in a range of $46 to $62 over the cost of the C-4 transmission.

4929 **(DOE/R6/12053—T1) Vehicular tire pressure measuring system. Final technical report.** Smith, J.B. (Smith (Jesse B.), Garland, TX (USA)). 30 Sep 1983. Contract FG46-80R612053. 17p. NTIS, PC A02/MF A01. Order Number DE84003426.

A device to measure and indicate tire pressure and location is described. It involves a passive pressure transducer and a noncontactive coupling between the transducer and the electrical receptor. The design alternatives, prototype system, problems encountered, field test, and design changes are discussed. (MHR)

3308 Alternative Fuels

REFER ALSO TO CITATION(S) 4513, 4522, 4917, 4919, 4921, 4922, 5393

36 MATERIALS

4930 **(DOE/ER/10482—T1) Melting phenomena investigated by laser light scattering. Interim progress report through September 1, 1983.** Cummins, H.Z. (City Coll., New York (USA). Dept. of Physics). 1983. Contract AC02-79ER10482. 4p. NTIS, PC A02/MF A01. Order Number DE84002004.

A brillouin and Raman scattering investigation produced data on the premelting phenomena in the molecular crystal salol. The defect formation energy decreases sharply near the melting point, leading to a super-exponential growth in defect concentration. (DLC)

4931 **(UCID—18574-83-1) H Division: materials physics. Quarterly report, January-March 1983.** Young, D.A. (Lawrence Livermore National Lab., CA (USA)). 15 Sep 1983. Contract W-7405-ENG-48. 81p. NTIS, PC A05/MF A01. Order Number DE84001083.

Studied were: x-ray absorption spectroscopy of shocked plasmas, thermal expansion and electric resistivity of liquid Ti, reflection spectra of IBr and Br_2, ultrahigh pressure equation of state of Al from pseudopotential theory, electric conductivity of dense molecular H_2, a Van der Waals one-fluid model for quantum-mechanical mixtures, autoionization rates for doubly excited states of Kr^{23+}, model for plotting K-shell line ratios, blast loading of spheri-

cal container in elastic medium, a 3-D Bauschinger effect model, and plastic flow of polycrystalline Ag. (DLC)

3601 Metals And Alloys

REFER ALSO TO CITATION(S) 4279, 4376, 4457, 4505, 4593, 4598, 5540, 5591

4932 **(BNL—33827) Investigation of the ferromagnetic-spin glass transition in a-($Fe_{77}Cr_{23})_{75}P_{16}B_6Al_3$.** Wicksted, J.P.; Shapiro, S.M.; Chen, H.S. (Brookhaven National Lab., Upton, NY (USA); Bell Labs., Murray Hill, NJ (USA)). Oct 1983. Contract AC02-76CH00016. 13p. (CONF-831187—10). NTIS, PC A02/MF A01. Order Number DE84002874.

From MMM conference; Pittsburgh, PA, USA (8 Nov 1983).

Elastic and inelastic neutron scattering studies were performed on the amorphous alloy $(Fe_{77}Cr_{23})_{75}P_{16}B_6Al_3$. These measurements were conducted over a temperature range from 1.8 K to room temperature. The elastic scattering results obtained at Q = $0.025A^{-1}$ indicated a Curie temperature of 185°K in addition to a ferromagnetic-spin glass transition below 20 K. These values are consistent with the phase diagram construction resulting from the magnetization and ac susceptibility measurements of Yeshurun et al. Inelastic neutron scattering measurements resulted in well-defined spin waves being observed in the ferromagnetic phase. For the small Q range studied ($0.05A^{-1}$ to $0.1A^{-1}$), the spin wave energies followed a quadratic dispersion. As the temperature was lowered towards the spin glass regime, the spin wave energies decreased indicating a softening of the magnetic stiffness constant. Below 10°K, no well-defined spin wave excitations were present; however, a quasielastic peak, which increased slightly as the temperature was lowered, was observed.

4933 **(BNL—33849) Investigation of the paramagnetic phase of bcc iron using polarized neutron scattering.** Wicksted, J.P.; Shirane, G.; Steinsvoll, O. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 10p. (CONF-831187—11). NTIS, PC A02/MF A01. Order Number DE84002857.

From MMM conference; Pittsburgh, PA, USA (8 Nov 1983).

Recent neutron scattering experiments on Ni and Fe (4%-Si) above T/sub c/ have demonstrated that a simple paramagnetic scattering function $S(Q\omega)$ proportional to $1/(\kappa_1^2 + q^2).\Gamma/(\Gamma^2 + \omega^2)$ can explain the persistent spin wave ridges previously reported by Lynn and Mook. We present our new polarized beam results on pure Fe and describe in some detail the special problems associated with the unpolarized beam studies of magnetic cross sections at high temperatures.

4934 **(BNL-NUREG—33841) Electrochemical kinetics in stress-corrosion cracks.** Newman, R.C.; Isaacs, H.S.; Sieradzki, K. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 14p. (CONF-8310205—2). NTIS, PC A02/MF A01 - GPO. Order Number DE84002855.

From TMS-AIME fall meeting; Philadelphia, PA, USA (2 Oct 1983).

Several unconventional techniques have been used to examine the electrochemistry of stress-corrosion crack growth. These include the measurement of bare surface dissolution and passivation kinetics in a series of possible simulations of the crack tip solution, load pulsing, alteration of the bulk solution during crack growth, and the measurement of electrochemical noise accompanying discontinuous crack growth at controlled potentials. Currents from individual cracks have also been measured with sensitivity using a scanning vibrating electrode technique. The stability of stress-corrosion cracking in the presence of an altered crack tip environment is discussed.

4935 **(CONF-821049—27) Embrittlement effects of liquid alkali metals on structural materials.** Natesan, K. (Argonne National Lab., IL (USA)). Oct 1982. Contract W-31-109-ENG-38. 18p. NTIS, PC A02/MF A01. Order Number DE84003626.

From TMS/AIME fall meeting(Radiation damage analysis for fusion reactors); St. Louis, MO, USA (24 Oct 1982).

Interactions between alkali metals and structural materials are of considerable interest in view of the role of liquid alkali metals as heat-transport media in a number of advanced energy-generation concepts. In general, exposure to alkali metals per se does not result in embrittlement of structural materials, but the transfer or partitioning of interstitial elements, such as oxygen, carbon, and nitrogen, between the liquid and the solid can lead to significant degradation of the mechanical properties of the structural materials. The present paper examines the partitioning of several interstitials between Group IA liquid alkali metals and a number of structural materials, such as austenitic stainless steels and refractory metals/alloys, with emphasis on the mechanical properties of the materials.

4936 **(CONF-830659—14) Creep properties of modified 9 Cr-1 Mo steel.** Sikka, V.K.; Cowgill, M.G.; Roberts, B.W. (Oak Ridge National Lab., TN (USA); Westinghouse Electric Corp., Madison, PA (USA)). 1983. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE84003174.

From TMS/AIME topical conference on ferritic alloys for use in nuclear energy technologies; Snowbird, UT, USA (19 Jun 1983).

Creep properties of modified 9 Cr-1 Mo steel, an alloy significantly improved in elevated-temperature strength over 2 1/4 Cr-1 Mo and other similar alloys, are presented here. Data are primarily on material in the normalized and tempered condition. Effects of variables such as isothermal annealing treatment, cold work, normalizing temperature, tempering temperature, notch, and biaxial stress state have also been examined. Data analysis and comparisons have shown that modified 9 Cr-1 Mo alloy is very insensitive in response to several material variables, heat treatments, and specimen design variables.

4937 **(CONF-830659—15) Microstructure of HFIR-irradiated 12-Cr 1 MoVW ferritic steel.** Vitek, J.M.; Klueh, R.L. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01. Order Number DE84003291.

From TMS/AIME topical conference on ferritic alloys for use in nuclear energy technologies; Snowbird, UT, USA (19 Jun 1983).

As part of the fusion materials development program in the United States, a 12 Cr-1 MoVW ferritic steel was irradiated in the High Flux Isotope Reactor (HFIR) to a damage level of 36 dpa at 300, 400, 500, and 600°C. During irradiation in HFIR, a transmutation reaction of nickel results in the production of helium, to a level of 99 at. ppM in the present experiment. The microstructures were evaluated after irradiation and the results are presented. Cavities were found at all temperatures. Small cavities (3 to 9 nm) were observed after irradiation at 300, 500 and 600°C. At 500 and 600°C, the cavities were found preferentially at dislocations, lath boundaries, and prior austenite grain boundaries. After irradiation at 400°C, larger cavities (4 to 30 nm) were observed homogeneously distributed throughout the tempered martensite structure. The maximum swelling was 0.07% after irradiation at 400°C. Comparision of the results with other studies in which helium was not present at such high levels indicated helium enhances the swelling of 12 Cr-1 MoVW.

4938 **(CONF-830659—19) Effect of heat treatment on the impact properties of a 12Cr-1Mo-V-W steel.** Chin, B.A.; Wilcox, R.C. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). 11 Nov 1983. Contract AS05-82NE37900. 10p. NTIS, PC A02/MF A01. Order Number DE84003440.

From TMS/AIME topical conference on ferritic alloys for use in nuclear energy technologies; Snowbird, UT, USA (19 Jun 1983).

This paper describes the effects of austenitization and tempering treatments on the strength and impact properties of a 12Cr-1Mo-V-W steel. Data are reported for austenitization temperatures covering the range 900 to 1250°C and tempering treatments of 600 to 800°C. A 50°C improvement in the ductile brittle transition temperature is achieved through heat treatment. This is found to result from elimination of delta ferrite and associated carbides at the delta ferrite-matrix interface. 17 figures.

4939 **(CONF-830719—57) Effect of shock duration on the dynamic consolidation of powders.** Schwarz, R.B.; Kasiraj, P.; Vreeland, T. Jr.; Ahrens, T.J. (California Inst. of Tech., Pasadena (USA)). Sep 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE84003571.

From American Physical Society meeting on shock waves in condensed media; Santa Fe, NM, USA (18 Jul 1983).

A recent advanced model for the shock consolidation of powders predicts, for a powder given distension, the regimes of shock pressure and shock duration expected to yield fully densified compacts of near optimum strength. The model is evaluated in terms of UTS measurements in compacts of rapidly solidified powders of AISI 9310 alloy, shocked to initial shock pressures between 3.6 and 17.9 GPa and to shock durations between 0.23 and 2.1 μs. We find that in powders of distention 1.7, shock durations > 1 μs are required at 10 GPa to properly solidify the melt.

4940 **(CONF-830719—58) Shock compaction of molybdenum powder.** Ahrens, T.J.; Kostka, D.; Vreeland, T. Jr.; Schwarz, R.B.; Kasiraj, P. (California Inst. of Tech., Pasadena (USA); Argonne National Lab., IL (USA)). Sep 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE84003713.

From American Physical Society meeting on shock waves in condensed media; Santa Fe, NM, USA (18 Jul 1983).

Shock recovery experiments carried out in the 9 to 12 GPa range on 1.4 distension Mo appear adequate to compact to full density (< 45 μm) powders. However, the stress levels are below those calculated to be from 100 to $\sim$ 22 GPa which a frictional heating model predicts are required to consolidate $\sim$ 10 to 50 μm particles. The present model predicts that for powders have a distension of m=1.6 shock pressures of 14 to 72 GPa are required to consolidate Mo powders in the 50 to 10 μm range.

4941 **(CONF-831187—12) Temperature dependence of the field induced magnetic form factor of the intermetallic compound $PrSn_3$.** Loong, C.K.; Stassis, C.; Zarestky, J.; McMasters, O.D.; Moon, R.M. (Argonne National Lab., IL (USA); Ames Lab., IA (USA); Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE84003283.

From MMM conference; Pittsburgh, PA, USA (8 Nov 1983).

The spatial distribution of the magnetization induced by a magnetic field of 42.5 kG in a single crystal of $PrSn_3$ has been studied at 100 and 20 K using polarized neutron scattering techniques. At both temperatures the measured form factor is in good agreement with the theoretical 4f magnetic form factor of the Pr^{3+} ion. This result is in contrast to the large deviations from the 4f magnetic form factor of Ce^{3+} observed, at low temperature, for the mixed-valence compounds $CeSn_3$ and $CePd_3$. The localized static susceptibility of $PrSn_3$ at 100 and 20 K, obtained by extrapolating the measured form factor to the forward direction, agrees very well with bulk susceptibility measurements.

4942 **(CONF-831187—15) Neutron scattering study of the magnetic excitations in ferromagnetic iron at high energy transfers.** Loong, C.K.; Carpenter, J.M.; Lynn, J.W.; Robinson, R.A.; Mook, H.A. (Oak Ridge National Lab., TN (USA); Argonne National Lab., IL (USA); Los Alamos National Lab., NM (USA); Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1983. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE84003552.

From MMM conference; Pittsburgh, PA, USA (8 Nov 1983).

We have measured the spin-wave spectrum of iron by neutron inelastic scattering using the Low-Resolution Medium-Energy Chopper Spectrometer at the Intense Pulsed Neutron Source (IPNS) of the Argonne National Laboratory. Interest focuses on the magnetic excitations at high energy transfers where the spin-wave dispersion relation has not previously been determined. In measurements performed at 10K using a 23-gram single crystal of pure iron, we observed magnetic scattering around the (110) reciprocal lattice point with spin-wave energies from 40 to 160 meV. The spin-waves over the entire range of energy are found to be consistent with an isotopic spin-wave dispersion relation. With the present experimental sensitivity we were unable to observe any band structure effects such as Stoner excitations or optical magnons in this range of wave vector and energy.

4943 (DOE/ER—0045/10, pp 23-24) **Irradiation of miniature Charpy specimen of 12 Cr-1 MoVW: experiment HFIR-CTR-46.** Vitek, J.M. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

The HFIR-CTR-46-HFIR--46 experiment contains miniature Charpy V-notch specimens of the national fusion heat of 12 Cr-1 MoVW steel. Irradiation at 300°C and 400°C will achieve a midplane damage level of 10 dpa.

4944 (DOE/ER—0045/10, pp 25-26) **High fluence irradiation of ferritic steel Charpy specimens: experiments HFIR-CTR-47 and -48.** Vitek, J.M. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

The HFIR-CTR-47 and -48 experiments are companions of the earlier experiments HFIR-CTR-34 and -35 to achieve displacement damage levels up to 40 dpa in 9 Cr-1 MoVNb and 12 Cr-1 MoVW steels. Irradiation temperatures are 300 and 400°C. Nickel-doped alloys are included to assess the influence of helium on post-irradiation impact behavior.

4945 (DOE/ER—0045/10, pp 28-38) **Swelling and microstructural development of Path A PCA and type 316 stainless steel irradiated in HFIR.** Maziasz, P.J.; Braski, D.N. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

Evaluation of swelling of PCA variants and 20%-cold-worked (N-lot) type 316 stainless steel (CW 316) irradiated at 300 to 600°C was extended to $\sim$ 22 dpa. Voids continued to develop with increased fluence in PCA-A1, -B1, and CW 316. Void swelling saturated in PCA-B2 at $\sim$ 10 dpa at 600°C and did not develop in PCA-A3 up to 22 dpa. A stable structure of fine titanium-rich MC developed during irradiation of PCA-A3, while preexisting MC precipitate in PCA-B2 redistributes during irradiation.

4946 (DOE/ER—0045/10, pp 39-48) **Grain boundary microstructural development and stability for various pretreatments of Path A prime candidate alloy irradiated in HFIR.** Maziasz, P.J.; Braski, D.N. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

Irradiation to 22 dpa in HFIR at 500 and 600°C produced resolvable grain boundary bubbles in Path A PCA and CW 316. PCA-A1 had the coarsest bubble structure at 600°C and no MC precipitate. Medium to coarse distributions of MC developed at the boundaries by heat treatment of PCA-B1 and -B2 were stable under irradiation; very fine bubbles clustered about these particles at 600°C. The PCA also resisted sigma formation, compared with CW 316 (D0 heat) or SA 316 and 316 + Ti (R1 heat) irradiated in HFIR.

4947 (DOE/ER—0045/10, pp 49-52) **Tensile properties of unirradiated Path A prime candidate alloy.** Braski, D.N.; Maziasz, P.J. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

The tensile properties of Path A PCA in the A1, A3, and B2 conditions have been determined at temperatures from room temperature to 700°C. The 25%-cold-worked alloy, PCA-A3, showed strength values similar to those of the reference heat of 20%-cold-worked 316 stainless steel but exhibited a lower ductility in the 200 to 300°C range.

4948 (DOE/ER—0045/10, pp 53-59) **Effect of the microstructure on tensile properties of type 316 stainless steel.** Klueh, R.L. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

A series of tensile specimens that had been given different thermal and mechanical processing treatments was irradiated in the ORR at 250, 290, 450, and 500°C to a neutron fluence of about 6.8 x 10^{25} neutrons/m^2 (>0.1 MeV) (~ 5 dpa and 40 at. ppM He). The tensile properties of irradiated and unirradiated steel with 20, 30, and 50% cold work were determined at the irradiation temperatures.

4949 (DOE/ER—0045/10, pp 60-64) **Tensile properties and swelling of 20%-cold-worked type 316 stainless steel irradiated in HFIR.** Klueh, R.L.; Grossbeck, M.L. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

Immersion density and elevated-temperature tensile properties were determined on 20%-cold-worked type 316 stainless steel irradiated in the HFIR to fluences of 1.8 to 3.7 x 10^{26} neutrons/m^2 (>0.1 MeV), which resulted in 16 to 32 dpa and 1250 to 2000 at. ppM He. These data were combined with the data obtained in two previous experiments, one to similar fluences and one to higher fluences (up to 6.3 x 10^{26} neutrons/m^2).

4950 (DOE/ER—0045/10, pp 65-69) **Fracture strain of 20%-cold-worked type 316 stainless steel under irradiation in EBR-II.** Grossbeck, M.L.; Bloom, E.E. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

Swelling-driven fracture strain specimens of 20%-cold-worked 316 stainless steel were irradiated to a fluence of 5 x 10^{26} neutrons/m^2 (>0.1 MeV) in EBR-II at 430, 550, and 625°C. Fracture strain was not a function of fluence or strain rate but only of temperature. Fracture strain was found to be 6% at 550°C and 1% at 625°C. All fractures were intergranular, but a notched specimen irradiated at 550°C showed some evidence of ductility.

4951 (DOE/ER—0045/10, pp 74-80) **Mechanical property evaluations of Path C vanadium scoping alloys.** Bajaj, R.; Gold, R.E. (Westinghouse Electric Corp., Pittsburgh, PA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

This report updates the data on the creep/stress rupture of the vanadium-base scoping alloys containing zero, 600 wppm and 1200 wppm additional oxygen. The conclusions drawn earlier that V-15Cr-5Ti shows superior creep/stress rupture properties to V-20Ti and VANSTAR-7 alloys and that addition of 1200 wppm oxygen has no major effect on the creep rupture properties remain valid. The additional fractography presented here confirms the ductile nature of these alloys.

4952 (DOE/ER—0045/10, pp 81-86) **Weldability of Path C vanadium alloys.** Gold, R.E.; Bajaj, R. (Westinghouse Electric Corp., Pittsburgh, PA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

Gas tungsten arc welds were prepared for each of the three vanadium-base (Path C) scoping alloys using semi-automatic, full penetration, bead-on-sheet welds. The bend ductile-brittle transition temperatures (DBTTs) of these welds and base metal specimens were determined. In terms of weldability the alloys were ranked: (best) V-20Ti, V-15Cr-5Ti, VANSTAR-7. The bend DBTT values for weld specimens were: V-20Ti, -196/-150°C; V-15Cr-5Ti, -20/+50°C; VANSTAR-7, -75/-50°, for longitudinal/transverse bend tests.

4953 (DOE/ER—0045/10, pp 87-90) **Evaluation and development of vanadium-base alloys for fusion reactor applications.** Loomis, B.A.; Smith, D.L. (Argonne National Lab., IL). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

The corrosion of pure V and V-5Ti, V-15Cr and V-15Cr-5Ti alloys at 725°K and 825°K in flowing helium containing 10 ppM water was determined for exposure times that yielded a steady-state corrosion rate. The experimentally determined corrosion rates for the V and V-base alloys were compared with the corrosion rate obtained for PCA stainless steel under the same environmental conditions. These results showed that the steady-state corrosion rates for the V-15Cr alloy and V-15Cr-5Ti alloy were low but approximately one order of magnitude greater than the steady-state corrosion rate determined for the PCA stainless steel. Also, the temperature dependence of the electrical resistivity for V and V-15Cr-5Ti alloy was determined for temperatures ranging from 77°K to 1000°K.

4954 (DOE/ER—0045/10, pp 92-93) **Status of scaleup of an iron-base long-range-ordered alloy.** Roche, T.K.; Braski, D.N.; Liu, C.T. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Semiproduction scaleup of the iron-base alloy LRO-37 has been successfully completed. Three ingots of the alloy were produced by a commercial source, hot forged to slab, then rolled to 3.3-, 1.6-, and 0.8-mm sheet stock. The high-purity material contained MC-type carbides, and $M_3(C,N)$-type carbides were observed in commercial-grade alloy.

4955 (DOE/ER—0045/10, pp 94-98) **Bend ductility of iron-base long-range-ordered alloys after irradiation in HFIR.** Braski, D.N. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Three iron-base LRO alloys with base composition $(Fe,Ni)_3V$ tested at 600°C exhibited intergranular fracture and reduced bend ductilities after irradiation to 10 dpa at 600°C in HFIR. The embrittlement extended to lower temperatures as the damage level increased. The weakness of the grain boundaries may be caused by the presence of helium, segregating elements, VC particles, or a combination of these factors.

4956 (DOE/ER—0045/10, pp 100-103) **Preliminary transmission electron microscopy of 12 Cr-1 MoVW irradiated to 40 dpa in HFIR.** Vitek, J.M.; Klueh, R.L. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Specimens of 12 Cr-1 MoVW steel were irradiated in HFIR to 40 dpa at 400 and 600°C. Preliminary microstructural examination indicates significant cavity formation in this steel, and this is attributed in part to the helium produced during irradiation.

4957 (DOE/ER—0045/10, pp 104-107) **Elevated-temperature tensile properties of 12 Cr-1 MoVW steel irradiated in the EBR-II, AD-2 experiment.** Klueh, R.L.; Vitek, J.M. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

The effect of irradiation on the tensile properties of 12 Cr-1 MoVW steel in two normalized-and-tempered conditions was deter-

mined for specimens irradiated in EBR-II at 390 to 550°C. Tests were conducted at room temperature and at the irradiation temperature. Irradiation to approximately 11 dpa increased the ultimate tensile strength for each irradiation temperature; an increased yield stress was noted only at the lowest temperature.

4958 (DOE/ER—0045/10, pp 108-124) **Fatigue crack growth in Path E alloys.** Ermi, A.M. (Westinghouse Hanford Co., Richland, WA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Fatigue crack growth tests on unirradiated HT-9, HT-9 weldments and 9Cr-1Mo have been conducted in helium at temperatures up to 550°C and at cyclic frequencies of 6.67 and 0.667 s^{-1}. Little differences in crack growth behavior between the three materials were observed at any single condition. However, higher crack growth rates were evident at the lower stress intensity factors at 0.667 s^{-1} on specimens tested at 300°C compared to 550°C. No effect of irradiation was observed on HT-9 irradiated to 13 dpa at 550°C and tested at 550°C at 6.67 s^{-1}.

4959 (DOE/ER—0045/10, pp 125-130) **Fracture toughness of irradiated HT-9 weld metal.** Huang, F.H.; Gelles, D.S. (Westinghouse Hanford Co., Richland, WA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Fracture toughness tests using electropotential techniques on HT-9 weld material irradiated to a fluence of 2.8 x 10^{22} (E > 0.1 MeV) at 390a)C were performed at 93, 205, 316 and 427°C. Testing of HT-9 welds irradiated at 450, 500 and 550°C was performed at 205°C. The test results were analyzed using the J-integral approach. After the test, the specimens were examined by scanning electron microscopy in order to understand the fracture process in this weld material. The test results show that irradiation temperature has little effect on the fracture toughness of HT-9 weld metal. In addition, it was found that for the 390°C irradiation condition, testing at 93 and 427°C showed little change in fracture toughness after irradiation. However, testing at 200 to 300°C resulted in higher toughness, higher than that of unirradiated material.

4960 (DOE/ER—0045/10, pp 131-137) **Effect of specimen size and material condition on Charpy impact properties of 9 Cr-1 MoVNb.** Corwin, W.R.; Hougland, A.M. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Charpy-impact properties were determined on full- and subsize specimens of normalized-and-tempered as well as quenched-only 9Cr-1MoVNb steel. The subsize specimen produced consistently smaller fractional drops in the upper-shelf energy and larger shifts in the transition temperature than did the full-size specimen. Area and volumetric normalizations of the specimen size effect were also performed.

4961 (DOE/ER—0045/10, pp 138-146) **Toughness of simulated heat-affected zone microstructures in HT-9 (ESR melt practice).** Lippold, J.C. (Sandia National Labs., Livermore, CA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

The toughness behavior of the heat-affected zone in the ESR National Fusion Heat was determined using Gleeble-simulated microstructures. Two regions of the HAZ were evaluated; one region represents the portion of the HAZ nearest the fusion zone, the other corresponds to a region which is heated only slightly above the upper critical temperature. Charpy V-notch results indicated that following a PWHT at 760°C for 1 hour both regions of the HAZ exhibit superior toughness behavior to that of the quench-and-tempered base material. The upper shelf toughness increased 20 to 40 Joules and the DBTT decreased nearly 20°C relative to the base metal. The toughness of both the ESR base material and HAZ microstructures was superior to that of the AOD-processed National Fusion Heat, which had been previously tested in a similar manner.

4962 (DOE/ER—0045/10, pp 147-154) **Influence of prior cold work on the hydrogen charged tensile fracture of a 12Cr-1Mo steel.** Garrison, W.M. Jr.; Hyzak, J.M. (Sandia National Labs., Livermore). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Prior research on the tensile behavior of quenched-and-tempered 12Cr-1Mo steel has shown that the alloy is susceptible to grain boundary cracking in both the hydrogen charged and uncharged conditions. In the present study, the quenched-and-tempered material has been cold worked by swaging to determine how distortion of the prior austenite grain boundaries affects the hydrogen charged fracture process. Quenched-and-tempered bar stock was swaged to one of three different final reductions and tested in both the cold worked condition and after retempering to reduce the strength to the original quenched-and-tempered level. Tensile tests were performed on the specimens in both the hydrogen charged and uncharged conditions. Swaging and retempering improved both the uncharged and hydrogen charged tensile ductilities compared to the original quenched-and-tempered properties. For the largest swaging reduction, the uncharged tensile ductility (R/sub A/) increased by 13%, and the hydrogen charged tensile ductility was 55% compared to 18% for the quenched-and-tempered specimens. The improvement in tensile ductility for the swaged-and-retempered specimens was associated with changes in fracture mode compared to the quenched-and-tempered material.

4963 (DOE/ER—0045/10, pp 155-162) **Effect of preheat on the microstructure, hardness and toughness of HT-9 weldments.** Lechtenberg, T.A.; Foulds, J.R. (GA Technologies, Inc., San Diego, CA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Prior studies have shown that HT-9 plates up to 1" thick can be successfully welded with preheats as low as 100°C. The use of a 100°C preheat of the base metal prior to welding HT-9 results in an increased toughness over that for a 400°C preheat by about 13.5 Joules and a ductile-brittle transition temperature of -12°C which is 14°C lower than for 400°C preheated condition. SEM examinations showed that there were significant increases in the dendrite spacing and increased segregation due to the slower cooling rates in the 400°C preheat weld. This segregation is commensurate with depletion of the ferritizers Cr, Mo, and W in the surrounding matrix accompanied by increases in the Ni concentrations. These results indicate the lowest preheat compatible with good welding practice should be used.

4964 (DOE/ER—0045/10, pp 163-171) **Assessment of fabrication methods for an HT-9 first wall/blanket module.** Lechtenberg, T.A.; Hildebrand, J.F. (GA Technologies, Inc., San Diego, CA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

The first wall/blanket module structure for the TASKA tandem mirror reactor design is discussed relative to proposed materials and procedures for the fabrication. The TASKA design is a major reactor study for a near-term engineering test facility, the main objective of which was to develop a preconceptual design that could provide engineering design information for a Demonstration Fusion Power Reactor. This design was chosen for this study because HT-9 was used as the structural material and $Pb_{83}Li_{17}$ liquid metal as the breeder/coolant for the central cell modules, and presently is the only complete reactor study having done so. From the design, an assessment was made of materials, product forms and methods of assembly, heat treating, and joining to produce the unit. The results show that HT-9 can be used as a structural material for TASKA blankets. The tubes are 10.14 cm O.D. and 0.117 cm thick and cold bent to conform to the required shape of less than the manufacturers recommended maximum 2d bend radius. Welding recommendations include preheat of not less than 250°C and a post-weld heat treatment of 760°C for 2.5 hrs. The configuration of the pipe-to-manifold weldments and inspectability requirements suggests this module can be manufactured to present-day code requirements. Furthermore, the essential leak-tightness for

a pressure boundary in the tubes appears practical. The results indicate a good feasibility that the proposed TASKA can be fabricated.

4965 (DOE/ER—0045/10, pp 172-173) **Irradiation of ESR Alloy HT-9 and Alloy 9Cr-1Mo(Mod.) plates for fracture toughness assessment.** Hawthorne, J.R. (Naval Research Lab., Washington, DC). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

During this period, irradiation exposures at 300°C and 150°C to 8 x 10^{19}n/cm^2, E > 0.1 MeV, were undertaken for the Alloy HT-9 and Alloy 9Cr-1Mo(Mod.) plates, respectively. Specimen types include tension, Charpy-V(C/sub v/), fatigue precracked Charpy-V(PCC/sub v/) and half-size Charpy-V specimens and, in the case of the Alloy 9Cr-1Mo(Mod.), 2.54 mm thick compact tension specimens.

4966 (DOE/ER—0045/10, pp 186-190) **Corrosion of Path A PCA, type 316 stainless steel, and 12 Cr-1 MoVW steel in flowing lithium.** Tortorelli, P.F.; DeVan, J.H. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

In lithium thermal convection loop (TCL) experiments, weight losses and dissolution rates of annealed and cold-worked path A prime candidate alloy (PCA), were slightly higher than those of type 316 stainless steel. The depth of the ferrite layer on type 316 stainless steel was constant between 3700 and 9000 h at 600°C but not at 570°C. Nitrogen level between 9 and 130 wt ppM in lithium did not affect short-term weight losses of type 316 stainless steel. The 12Cr-1MoVW steel showed measurable but small weight losses in thermally convective lithium between 350 and 500°C.

4967 (DOE/ER—0045/10, pp 191-194) **Corrosion of type 316 stainless steel in static Pb-17 at. % Li.** Tortorelli, P.F.; DeVan, J.H. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

The surface morphology and composition of type 316 stainless steel specimens exposed to static Pb-17 at. % Li between 400 and 700°C were studied. Preliminary results indicated nickel depletion throughout this temperature range and relative chromium surface enrichment for those specimens suffering the highest weight losses.

4968 (DOE/ER—0045/10, pp 195-200) **Environmental effects on properties of structural alloys.** Chopra, O.K.; Smith, D.L. (Argonne National Lab., IL). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Corrosion data are presented for several austenitic and ferritic steels exposed at temperatures between 700 and 755 K in flowing lithium and Pb-17 Li environments. The results indicate that dissolution rates for both steels are an order of magnitude greater in Pb-Li than in lithium. Tensile data for cold-worked Type 316 stainless steel show that a flowing environment has no effect on the tensile properties of Type 316 stainless steel at temperatures between 473 and 773 K.

4969 (DOE/ER—0045/10, pp 201-203) **Compatibility of vanadium alloys with high-temperature water.** Tortorelli, P.F.; DeVan, J.H. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Weight gains of Path C vanadium alloys (V-20% Ti, V-15% Cr-5% Ti, Vanstar-7) exposed to 300°C water for 100 h were relatively small and not significantly affected by hydrogen overpressure.

4970 (DOE/ER—0045/10, pp 204-208) **Compatibility studies of structural alloys with solid breeder materials.** Chopra, O.K.; Smith, D.L. (Argonne National Lab., IL). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

Compatibility tests between ferritic HT-9 alloy or Fe-9Cr-1Mo steel and Li_2O pellets in a flowing helium environment indicate that the reaction rates in helium containing 93 ppM H_2O are greater than in helium with 1 ppM H_2O. All alloy specimens gain weight whereas the Li_2O pellets lose weight after exposure. Data on the reaction kinetics and metallographic evaluation of the alloy specimens are presented.

4971 (HEDL-SA—2911-FP) **Neutron cross sections for defect production by high-energy displacement cascades in copper.** Heinisch, H.L.; Mann, F.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1983. Contract AC06-76FF02170. 6p. (CONF-830942—59). NTIS, PC A02/MF A01. Order Number DE84002116.

From 3. topical meeting on fusion reactor materials; Albuquerque, NM, USA (19 Sep 1983).

Defect production cross sections for copper have been devised, based on computer simulations of displacement cascades. One thousand cascades ranging in energy from 200 eV to 200 keV were generated with the MARLOWE computer code. The cascades were subjected to a semi-empirical cascade quenching procedure and to short-term annealing with the ALSOME computer code. Functions were fitted to the numbers of defects produced as a function of primary knock-on atom (PKA) damage energy for the following defect types: 1) the total number of point defects after quenching and after short-term annealing, 2) the numbers of free interstitials and free vacancies after shortterm annealing, and 3) the numbers and sizes of vacancy and interstitial clusters after short-term annealing. In addition, a function describing the number of distinct damage regions (lobes) per cascade was fitted to results of a graphical analysis of the cascade configurations. The defect production functions have been folded into PKA spectra using the NJOY nuclear data processing code system with ENDF/B-V nuclear data to yield neutron cross sections for defect production in copper. The free vacancy cross section displays much less variation with neutron energy than the cross sections for damage energy or total point defects.

4972 (KFK—3519) **Transmission electron microscopy of coevaporated Nb_3Ge films.** Yin, D.; Schauer, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Technische Physik). May 1983. 23p. Kernforschungszentrum Karlsruhe (Germany, F.R.).

The microstructure of Nb_3Ge thin film superconductors coevaporated onto heated molybdenum foil substrates has been investigated by transmission electron microscopy (TEM) using a 200 kV Hitachi 700H electron microscope. Specimens for a large area TEM inspection were prepared by applying a new chemical etching technique. Various kinds of defects could be indentified in high Tsub(c) films. For example, a large part of grain boundaries is shown to consist of dislocation networks. Two kinds of Nb_5Ge_3 second phase precipitates have been revealed by dark field imaging: a lamellar and a granular structure. Several other types of imperfections like twins and stacking faults have been seen. Occasionally observed striations in high resolution TEM photographs of high Tsub(c) Nb_3Ge films are similar in appearance to the martensitic lamellae seen in V_3Si samples below the transformation temperature.

4973 (LA-UR—83-3443) **Muon spin relaxation in spin glass PdMn.** Heffner, R.H.; Leon, M.; Schillaci, M.E.; Dodds, S.A.; Gist, G.A.; MacLaughlin, D.E.; Mydosh, J.A.; Nieuwenhuys, G.J. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 15p. (CONF-831187—14). NTIS, PC A02/MF A01. Order Number DE84003816.

From MMM conference; Pittsburgh, PA, USA (8 Nov 1983).

Muon spin relaxation (μSR) rates have been measured in transverse, longitudinal, and zero applied field for the spin glass PdMn (7 at. %), and are compared with a previous study of the

disordered ferromagnet PdMn (2 at. %). The calculated paramagnetic state transverse field relaxation rate for noninteracting spins is much larger than the observed rate in spin glass PdMn, but is in good agreement with ferromagnetic PdMn. The zero field relaxation rate shows a sharp cusp at T/sub g/=5K. An applied longitudinal field of 5 kG is insufficient to suppress this cusp in spin glss PdMn, but will suppress a similar cusp in ferromagnetic PdMn. Below T/sub g/=5K. An applied longitudinal field of 5 kG is insufficient to suppress this cusp in spin glass PdMn, but will suppress a similar cusp in ferromagnetic PdMn. Below T/sub g/, a distribution of quasistatic local fields is observed in zero field, which has the same temperature dependence for both samples. Comparisons with model calculations are discussed.

4974 **(LBL—16684) Diffusion in Fe-Cr-Al system at 900°C.** Akuezue, H.C. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 96p. NTIS, PC A05/MF A01. Order Number DE84002910.

Thesis.

Interdiffusion coefficient matrices, D/sub ij/'s have been experimentally measured at 31 points in the α δ Fe phase field of the Fe-Cr-Al ternary equilibrium phase diagram at 900°C. Analysis of the computed matrices were carried out by subjecting each measured D/sub ij/ to two consistency tests comprising of Onsager's and Kirkaldy's relations.

4975 **(N—8326989) Measurement of the carbon activity of sodium with foils consisting of Fe-20Mn and stainless steel types A304L and 316L.** Oberlin, C.; Saintpaul, P.; Baque, P.; Champeix, L. (UKAEA Risley Nuclear Power Development Establishment). Feb 1983. 26p. (CONF-791149—4-TRANS). British Library Lending Div., Boston Spa,;Engl.

From IWGFR specialists meeting on carbon in sodium; Harwell, UK (26 Nov 1979).

In Proc. of Specialists Meeting on Carbon in Sodium, IWGFR/33, 1979 p 122-131.

An exact knowledge of the carbon activity of sodium used as a heat transfer fluid in fast breeder reactors is essential to understand carburization and decarburization. At equilibrium the carbon activities in the sodium and in the metal alloy are equal and if the correlation between the carbon content and activity of the alloy concerned is known, it is possible to estimate the carbon activity in the sodium. The materials used must possess the following qualities: have a high carbon solubility at the temperatures of utilization or lead to a high ratio between the carbon contents of the material and sodium respectively, permit rapid equilibration with the sodium, not contain impurities which can falsify the results. The materials chosen in the light of these criteria were Fe-20Mn and AISI 304L and 316L stainless steels.

4976 **(ND-R—804(S)) Fatigue crack growth in simulated weld heat-affected zones in A533-B steel.** McMinn, A. (UKAEA Risley Nuclear Power Development Establishment). Oct 1982. 32p. H.M.S.O., London, price Pound 3.00.

Corrosion fatigue crack growth tests have been performed on a coarse-grained simulated heat-affected zone material, produced by heat treating A533-B plate. Tests have been carried out in air and simulated PWR water environments of low and high pH, at ambient temperature and pressure. The effects of cyclic frequency and stress ratio on corrosion fatigue crack growth rates have been examined. Stress ratio had the greatest effect on growth rates, accelerated growth being obtained under high stress ratio conditions, but in general environmental enhancements have been relatively small. All the corrosion fatique data fall well below the current ASME XI assessment curves. Mechanisms of crack growth have been discussed in the light of features observed on specimen fracture surfaces. A mixed mode of intergranular and transgranular fracture has been observed and it is thought that the growth mechanism is dissolution controlled. The intergranular fracture indicates that selective dissolution occurs along a pre-existing active path, thought to be the prior austenite grain boundaries. There is no evidence to suggest that the simulated HAZ microstructure is susceptible to hydrogen embrittlement induced crack growth.

4977 **(SAND—83-1234C) Microstructures of stainless steels exhibiting reduced friction and wear after implantation with Ti and C.** Follstaedt, D.M.; Yost, F.G.; Pope, L.E. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 7p. (CONF-831174—13). NTIS, PC A02/MF A01. Order Number DE84002252.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Implantation of Ti and C into stainless steel discs of Types 304, 15-5 PH, Nitronic 60 and 440C has previously been reported to reduce wear depths by up to ~ 85% and friction by ~ 50% in unlubricated pin-on-disc tests. Our earlier studies relating microstructure to friction and wear results in Type 304 are first summarized: these indicate that the improvements in the surface mechanical properties are due to an amorphous surface layer, similar to the amorphous layer observed in pure Fe implanted with Ti and C. We have now examined the other three implanted steels and found similar amorphous layers. These results strongly suggest that the amorphous surface alloy is responsible for reduced friction and wear in all the steels. 6 figures.

4978 **(SAND—83-2313C) Correlations between surface structure and catalytic reactivity for alkane hydrogenolysis over nickel.** Goodman, D.W. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 10p. (CONF-8307106—1). NTIS, PC A02/MF A01. Order Number DE84002610.

From 8. international congress on catalysis; Berlin, F.R. Germany (2 Jul 1983).

Kinetic studies over different crystal planes of nickel show the hydrogenolysis of n-butane to be structure sensitive. Significant differences in product formation rates are observed between the Ni(111) and the Ni(100) surfaces. The open (100) surface demonstrates a much higher activity toward rupturing carbon-carbon bonds than does the (111) surface. These results together with previous studies on ethane and cyclopropane hydrogenolysis confirm this result to be a general one. Furthermore an excellent comparison of the product distribution as a function of temperature between a Ni(100) catalyst and a polycrystalline nickel catalyst suggest that (100) facets dominate the chemistry of the polycrystalline surface.

4979 **(UCRL—89358) Decreasing the hydriding of uranium using ion implantation.** Musket, R.G.; Robinson-Weis, G.; Patterson, R.G. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 10p. (CONF-8310111—7). NTIS, PC A02/MF A01. Order Number DE84002150.

From 11. DOE annual compatibility meeting; Livermore, CA, USA (18 Oct 1983).

The hydriding of depleted uranium at 76 Torr hydrogen and 130°C has been significantly reduced by implantation of oxygen ions. The high-dose implanted specimens had incubation times for the initiation of the reaction after exposure to hydrogen that exceeded those of the non-implanted specimens by more than a factor of eight. Furthermore, the nonimplanted specimens consumed enough hydrogen to cause macroscopic flaking of essentially the entire surface in times much less than the incubation time for the high-dose implanted specimens. In contrast, the ion-implanted specimens reacted only at isolated spots with the major fraction of the surface area unaffected by the hydrogen exposure.

4980 **(UCRL—89360) Modification of the hydriding of uranium using ion implantation.** Musket, R.G.; Robinson-Weis, G.; Patterson, R.G. (Lawrence Livermore National Lab., CA (USA)). 4 Nov 1983. Contract W-7405-ENG-48. 17p. (CONF-831174—17). NTIS, PC A02/MF A01. Order Number DE84003247.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

The hydriding of depleted uranium at 76 Torr hydrogen and 130°C has been significantly reduced by implantation of oxygen ions. The high-dose implanted specimens had incubation times for the initiation of the reaction after exposure to hydrogen that exceeded those of the nonimplanted specimens by more than a factor of eight. Furthermore, the nonimplanted specimens consumed

enough hydrogen to cause macroscopic flaking of essentially the entire surface in times much less than the incubation time for the high-dose implanted specimens. In contrast, the ion-implanted specimens reacted only at isolated spots with the major fraction of the surface area unaffected by the hydrogen exposure.

4981 **(WIS-PH—82/15) Electric quadrupole interaction of $^{192}Tl(8^-)$ nuclei in hexagonal Tl and in tetragonal In metals.** Schatz, G.; Dafni, E.; Bertschat, H.H.; Broude, C.; Davidovsky, F.D.; Hass, M. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Apr 1982. 30p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703844.

The TDPAD technique has been used to measure the electric quadrupole coupling constants for the $^{192}Tl(8^-)$ isomer in hexagonal Tl at different temperatures and in tetragonal In at room temperature. The values measured were $e^2qQ/h = 24.0(15)$ MHz extrapolated to T = 0 K, and 33.1(16) MHz at 293 K for the Tl and In hosts, respectively. The electric field gradient for Tl impurities in In was determined from systematics of isoelectric systems, yielding $/Q[^{192}Tl(8^-)1]/ = 0.44(7)$ b. The almost perfect symmetry of the Tl crystalline structure makes this metal a sensitive probe to current models for electric field gradients in metals. The magnitude and temperature dependence of the field gradient in thallium metal are discussed within the framework of such models.

4982 **(WIS-PH—82/41) Reduced paramagnetism in γ-cerium.** Bertschat, H.H.; Broude, C.; Dafni, E.; Davidovsky, F.D.; Hass, M.; Lesser, P.M.S. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Aug 1981. 13p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703845.

The electronic structure of cerium ions in cerium metal has been investigated via time-differential perturbed angular distribution (TDPAD) measurements of the paramagnetic enhancement factor at several temperatures and zero pressure. A considerable reduction of the paramagnetic enhancement in γ-cerium was observed in comparison to systems where Ce is believed to be in the trivalent state, indicating the 4f electron to be partially delocalized. The results are discussed in the framework of a valence fluctuation model.

4983 **(PNL-tr—442) Influence of thermal neutrons on embrittlement of the liner steel of high-temperature reactors (HTR).** Alberman, A.; Pepin, P.; Soulat, P. (Pacific Northwest Lab., Richland, WA (USA); CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Nov 1983. Contract AC06-76RL01830. Translated from Fourth ASTM-Euratom symposium on reactor dosimetry, pp 839-845. (CONF-820321—31-Trans.). 14p. NTIS, PC A02/MF A01. Order Number DE84003475.

From 4. ASTM-EURATOM symposium on reactor dosimetry; Gaithersburg, MD, USA (22 Mar 1982).

An A 537 ferritic steel worthing for HTR vessel liner steel has been irradiated in the EL.3 heavy water reactor. Intense thermal/fast neutrons ratio has shown embrittlement effect. Transition temperature shift curves indicate relative damage effectiveness below 1/100.

4984 **Fracture toughness of CF8 castings at four kelvin.** Brown, E.L.; Tobler, R.L.; Whipple, T.A. (Department of Metallurgical Engineering, Colorado School of Mines, Golden, CO 80401). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 1179-1186(Jun 1983).

The first fracture toughness measurements for CF8 stainless steel castings in liquid helium at 4 K are reported. Single-phase (austenite) and duplex (austenite + δ-ferrite) castings were tested. On the basis of estimates from J-integral data, the plane-strain fracture toughness (K /SUB lc/) of castings containing 3.2 to 14.5 pct δ-ferrite ranged from 84 to 179 MPa X m /SUP 1/2/ at 4 K. In contrast, a fully austenitic casting (0 pct δ-ferrite) exhibited a K / SUB lc/ value of 331 MPa X m /SUP 1/2/ , which is nearly equivalent to the toughness of a wrought AISI 304 stainless steel of a similar strength. Light and scanning electron microscop studies indicate that the inferior toughness of castings containing δ-ferrite may be attributed to the brittleness of this body-centered-cubic phase at cryogenic temperatures and its distribution in th microstructure. The relative stability of the austenitic phase with respect to martensitic phase transformation may also play a significant role.

4985 **Chemistry and distribution of phases produced by solid state SiC/NiCrAl reaction.** Hall, E.L.; Jackson, M.R.; Kouh, Y.M.; Mehan, R.L. (General Electric Corporate Research and Development Center, Schenectady, NY 12301). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 781-790(May 1983). Contract AC02-79ER10413.

Aspects of the solid state reaction between SiC and a model superalloy consisting of Ni-20 at. pct Cr-10 at. pct Al at 1150°C are studied in detail using analytical electron microscopy. The metal reaction zone formed on the metal side of the original metal/ceramic interface is found to consist of a complex mixture of four phases: γ'-Ni_3Al, β-NiAl, α-Cr, and Ξ, a ternary Ni-Si-Al phase. The chemistry of each phase is determined using X-ray spectroscopy in the analytical electron microscope. The effect of silicon on the γ – γ' microstructure of the model superalloy is described, an is shown to alter the chemistry, morphology, and size of the γ' phase. The γ -- γ' lattice parameter mismatch is calculated from the chemistry data, and changes in this mismatch caused by silicon correlate well with γ' morphology changes. Finally, phase equilibria concepts are used to explain the presence and distribution of phases in the metal reaction zone.

4986 **Identification of zero-flux planes and flux reversals in several studies of ternary diffusion.** Kim, C.W.; Dayananda, M.A. (Department of Ordnance Engineering, Korean Military Academy, Seoul). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 857-864(May 1983). Contract AC02-81ER10814.

Several past studies of isothermal diffusion in ternary systems have been examined for the identification of zero-flux planes (ZFP) and flux reversals of the individual components. The phenomenon of ZFP initially recognized in the Cu-Ni-Zn diffusion couples has now been identified in several ternary systems including Cu-Ag-Au, Cu-Zn-Sn, Fe-Ni-Al, and Co-Ni-Cr. The development of ZFP is dictated by the terminal alloys of the diffusion couples and can occur in both single phase and multiphase assemblies. Discontinuous flux reversals can also occur at interfaces in multiphase systems. The compositions of ZFP's developed for a couple correspond to the intersections of its diffusion path and the isoactivity lines for the components drawn through the terminal alloy compositions on a ternary isotherm.

4987 **Thermotransport of hydrogen and deuterium in vanadium-niobium, vanadium-titanium, and vanadium-chromium alloys.** Peterson, D.T.; Smith, M.F. (Department of Materials Science and Engineering, Iowa State University, Iowa City, Iowa). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 871-874(May 1983). Contract W-7405-ENG-82.

Thermotransport of hydrogen and deuterium in vanadium alloyed with either niobium, titanium, or chromium is much greater than in pure vanadium, and additions of vanadium to niobium similarly increase thermotransport of hydrogen and deuterium over that observed in pure niobium. In all cases, the heat of transport was positive and was significantly greater for deuterium than for hydrogen. The results are consistent with an atomistic model in which the temperature dependence of atomic jump frequencies is the dominant factor in thermotransport with a small bias in the direction of atomic jumps. There is evidence that differences between the heats of transport for hydrogen and deuteriu may be related to isotope effects in the activation energies for diffusion.

4988 **High resolution scanning Auger microscopic investigation of intergranular fracture in as-quenched Fe-12Mn.** Lee, H.J.; Morris, J.W. Jr. (Lawrence Berkeley Laboratory). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 913-920(May 1983). Contract W-7405-ENG-48.

Previous research in this laboratory led to the conclusion that the low temperature intergranular fracture mode in Fe-Mn

alloys is microstructurally determined, and does not require metalloid segregation or other chemical contamination. That conclusion was tested in the present investigation, which used high resolution scanning Auger microscopy to study the intergranular fracture surfaces. The fracture mode at liquid nitrogen temperature was found to be intergranular fracture whenever the alloy was quenched from the austenite field, irrespective of the austenization time or temperature. High resolution chemical analysis of the intergranular fracture surfaces failed to reveal any consisten segregation of P, S, O, or N. The occasional appearance of sulfur or oxygen on the fracture surfac was found to be due to a low density precipitation of MnS and MnO_2 along the prior austenite grain boundaries. Excepting these dispersed precipitates, there was no evidence of manganese enrichment of the prior austenite grain boundaries. A slight segregation of carbon was found along the grain boundaries, but does not appear to be implicated in the tendency toward intergranular fracture. Th present results hence reinforce the conclusion that the low temperature intergranular fracture of Fe-12Mn is microstructurally determined.

4989 **Effects of neutron irradiation on annealed $Fe_{40}Ni_{40}P_{14}B_6$ glass.** Cline, C.F.; Hopper, R.W.; Johnson, W.L.; Tenhover, M. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *Scripta Metallurgica;* **17**: No. 5, 651-654(May 1983). Contract W-7405-ENG-48.

Melt-spun $Fe_{40}Ni_{40}P_{14}B_6$ alloy glass ribbon was annealed and irradiated with fast neutrons. The material as quenched, after annealing, and after annealing and irradiation was studied by mechanical testing, x-ray diffraction, differential scanning calorimetry, and Mossbauer spectroscopy.

4990 **Crack and cavity nucleation at interfaces during creep.** Yoo, M.H.; Trinkaus, H. (Oak Ridge National Laboratory, Oak Ridge, TN 37830). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 547-562(Apr 1983). Contract W-7405-ENG-26.

Athermal nucleation of microcracks and thermal nucleation of cavities during creep deformation are reviewed with an emphasis on effects of solute segregation to grain boundaries and cavity surfaces The magnitude and the duration of stress concentration at a triple grain junction or at a grain boundary inclusion are estimated for transient Coble creep and steady state power-law creep conditions. Stable configurations of wedge-type microcracks are predicted by a Griffith-like crack model. The rate fo thermal nucleation of cavities is obtained by the Fokker-Planck equation for vacancy clusters. Cracks and cavities are interdependent, and cavity nucleation occurs continuously throughout the three creep stages. The local stress concentration enhances microcrack and cavity nucleation. The cavity nucleation rate is generally increased as a result of solute segregation to the surfaces and interfaces and/or gas precipitation into cavity volume. This enhanced nucleation is more effective in a system with mobile solutes than with immobile solutes. Immobile solute or trace elements may affect the nucleation rate also by changing the grain boundary diffusivity. Experimental techniques for quantitative analyses of cavity nucleation processes are discussed.

4991 **The effects of segregation on the kinetics of intergranular cavity growth under creep conditions.** Nix, W.D.; Wang, J.S.; Yu, K.S. (Department of Materials Science and Engineering, Stanford University, Stanford, CA 94305). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 563-570(Apr 1983). Contract AT03-79ER10378.

Intergranular cavity growth under creep conditions is examined with particular reference to the potential effects of segregation on cavity growth. When cavities are present on all of the boundaries in a polycrystalline solid, they are able to grow in an unconstrained manner. Under these conditions the rate of cavity growth may be controlled by grain boundary diffusion (D /SUB GB/), surface diffusio (D /SUB S/), or power law creep, which in turn is controlled by lattice diffusion (D /SUB L/). When only isolated boundaries are cavitated, cavity growth is constrained and may be completely limited by creep flow of th surrounding grains. The segregation of solute to the grain boundary and the cavity surface can influence the kinetics of cavity growth in several different ways. The reduction in surface energy associated with segregation can increase the rate of cavity growth when the cavities are crack-like. The effects of segregation on grain boundary and surface diffusion can also influence the rate of cavity growth. A phenomenological relation proposed by Borisov et al indicates that D /SUB GB/ /D /SUB L/ decrease with segregation, thus causing grain boundary diffusion controlled cavity growth to be slowed by segregation. In some cases solute additions increase D /SUB L/ , thus increasing the rate of creep controlled cavity growth. When these effects are sufficiently large, D /SUB GB/ can increase with solute additions, in spite of the effect of segregation. In some alloys D /SUB S/ increases with segregation by several orders of magnitude. Similar effects on cavity growth are not expected even for surface diffusion controlled cavity growth because the rate of cavity growth is limited by other factors when D /SUB S/ is very large.

4992 **Residual and trace element effects on the high-temperature creep strength of austenitic stainless steels.** Swindeman, R.W.; Klueh, R.L.; Sikka, V.K. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 581-594(Apr 1983). Contract W-7405-ENG-26.

The heat-to-heat variation in the creep strength and ductility of austenitic stainless steels was reviewed from the viewpoint of residual and trace element effects. Based on data reported in the literature the creep strength of unstabilized alloys such as types 304 and 316 stainless steel increased with residual element and trace element content. Niobium appeared to be the most potent strengthener. There was no direct evidence that trace elements such as sulfur and phosphorus had a deleterious effect on either strength and ductility. It was assumed that the creep strength and ductility of the unstabilized grades of austenitic stainless steels are controlled by the precipitate characteristics. It follows from this that thermomechanical treatment or residual element additions that affect the precipitate characteristics influence subsequent time dependent mechanical properties. This view is consistant with most of the information in the literature. It was concluded that more systematic studies of trace and residual element effects would be beneficial to the improvement of steels. Incorporated into the studies should be quantitative characterization of evolving precipitate morphology and composition as they are in fluenced by residual elements. This information should be incorporated into modeling studies of nonequilibrium segregation. Ultimately, optimum elevated-temperature strength could be developed based on a materials science approach.

4993 **High temperature embrittlement of Ni and Ni-Cr alloys by trace elements.** White, C.L.; Padgett, R.A.; Schneibel, J.H. (Metals and Ceramics Division, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, TN 37830). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 595-610(Apr 1983). Contract W-7405-ENG-26.

The effects of Sb, Sn, and Zr additions on the creep properties of Ni and Ni + 20 pct Cr are reported. Antimony and tin additions (about 1 wt pct) induce extensive grain boundary cavitation in nickel, while smaller antimony additions had little effect on Ni + 20 pct Cr. Addition of 0.11 pct Zr to Ni + 20 pct Cr greatly inhibited grain boundary cavitation and reduced its Coble creep rate. Auger electron spectroscopy of cavitated specimens provided direct evidence of impurity segregation to cavity surfaces. Residual sulfur segregated most strongly, and was observed on cavity surfaces in all cavitated specimens. Tin segregated somewhat less intensely than sulfur, and antimony segregated only slightly. Segregation of antimony and sulfur to uncavitated portions of Ni + 1 pct Sb grain boundaries was also observed. These results are discussed in terms of segregation effects on energetic and transport properties of the grain boundaries and cavity surfaces.

4994 Irradiation induced precipitation in tungsten based, W-Re alloys. Williams, R.K.; Bentley, J.; Stiegler, J.O.; Wiffen, F.W. (Metals and Ceramics Division, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, TN 37830). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 655-666(Apr 1983). Contract W-7405-ENG-26.

Tungsten-base alloys containing 5, 11, and 25 pct Re were irradiated in the EBR-II reactor. Irradiation temperatures ranged from 600 to 1500°C. All compositions were irradiated to fluences in the range 4.3 to 6.1 X 10^{25} n/m² (E > 0.1 MeV), and three 25 pct Re samples were also irradiated to 3.7 X 10^{26} n/m² at temperatures 700 to 900°C. Postirradiation examination included measurement of electrical resistivity at room temperature and lower temperatures, X-ray diffraction, optical metallography, microprobe analysis, and transmission electron microscopy. Irradiation induced resistivity decreases observed in most of the samples suggested second-phase precipitation. Complete results confirmed the precipitate formation in all samples, in disagreement with existing phase diagrams for the W-Re system. Electron diffraction showed the precipitates to be consistent with the cubic, Re-rich /chi/-phase and inconsistent with the σ-phase. Large variations in precipitate morphology and distribution were observed between the different compositions and irradiation conditions. For the 5 and 11 pct Re-alloys, spherically symmetric strain fields surrounded the equiaxed precipitate particles, and were observed even where no particles were visible. These strain fields are believed to arise from local Re enrichment. Thermoelectric data show that the precipitation can lead to decalibration of W/Re thermocouples.

4995 The enhancement of hydrogen attack in steel by prior deformation. Clugston, S.F.; Shewmon, P.G.; Weertman, J.R. (Rotary Foundation Scholar, University of Auckland, Auckland). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 695-700(Apr 1983). Contract AC02-81ER10960.

An investigation has been made of the cause of enhancement of hydrogen attack (HA) by prior cold working. Bars of 1020 Si-killed steel deformed in three point bending were found to contain microcracks at ferrite/ferrite grain boundaries containing cementite inclusions and at ferrite/pearlite boundaries. Very long cementite plates crack, but shorter cementite inclusions ($\leqq \simeq 2$ μm) suffer decohesion from the matrix at or near the inclusion ends. The observed anisotropy of microcracking with respect to grain boundary orientation and sign of the deformation stress can be understood in terms of the stress state at the inclusion/matrix interface during deformation. The microcracks ar not eliminated by an annealing treatment which is known to cancel the effect of deformation on HA. It is concluded that residual stresses arising from the difference in deformability between cementite particles and matrix are responsible for the influence of deformation on HA.

4996 Isotropy of spinodal decomposition in Fe-30% Cr. Spooner, S.; Brundage, W.E. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, TN 37820). *Scripta Metallurgica;* **17**: No. 4, 573-574(Apr 1983). Contract W-7405-ENG-26.

Until recently, only Mossbauer spectroscopy was successfully employed in an atomic scale structural analysis of spinodally decomposed iron-chromium alloys. X-ray diffraction and electron microscopy have not been used because electron density contrast and lattice strain effects are too small to give observable effects. Recent neutron diffraction work was the only source of structure information until the very recent field ion microscopy work of Soffa et al. Although it is suggested that there should be no directionality in the spinodal decomposition in iron-chromium system there has been no experimental demonstration of this expectation. Neutron scattering work on Fe-Cr by Japanese workers has also come to attention. Their work on polycrystalline samples does not explore the question of scattering anisotropy. This note reports the results of neutron scattering measurements made on a single crystal of iron-30% chromium which has been decomposed within the spinodal region of the miscibility gap.

4997 Some considerations on the modelling of oxide-induced fatigue crack closure using solutions for a rigid wedge inside a linear elastic crack. Suresh, S.; Ritchie, R.O. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Materials Science and Mineral Engineering, University of California, Berkeley, California 94720). *Scripta Metallurgica;* **17**: No. 4, 575-581(Apr 1983). Contract AC03-76SF00098.

The formation of insoluble corrosion deposits within slowly growing cracks exposed to active environments can produce a mechanical wedging action which can either promote sustained-load cracking or retard cracking under cyclic loads. In the latter case, this wedging action has been shown to be particularly significant for fatigue cracks propagating at near-threshold levels. In such instances oxide deposits can accumulate near the crack tip to thicknesses some 20 times the naturally-occurring oxide thickness in ambient temperature moist air atmospheres due to a mechanism of "fretting oxidation" from the combined action of plasticity-induced crack closure and Mode II crack tip displacements characteristic of near-threshold crack extension. The result of such oxide deposits under cyclic loading is to promote crack tip blunting and more importantly to enhance crack closure through a mechanism which has become known as oxide-induced crack closure. This effect, however, is most relevant to fatigue cracks growing at near-threshold levels, at low load ratios, in lower strength materials, and of course in environments which promote the formation of corrosion deposits. Recently, attempts have been made to model the role of oxide-induced closure in suppressing rates of environmentally-influenced fatigue crack growth using stress intensity solutions for a rigid wedge inside a linear elastic crack. The purpose of this note is to examine the significance and limitations of this approach in the light of recently available experimental information on near-threshold corrosion fatigue behavior.

4998 Solid state SiC/Ni alloy reaction. Jackson, M.R.; Davis, A.M.; Hall, E.L.; Mehan, R.L. (General Electric Corporate Research and Development, Schenectady, NY 12345). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 355-492(Mar 1983). Contract AC02-79ER10413.

The solid state reaction between silicon carbide and a model superalloy consisting of 70 at. pct Ni, 20 at. pct Cr, and 10 at. pct Al was studied between 700°C and 1150°C for times ranging from "0" hours to 330 hours. Reaction couples consisting of SiC/Ni, SiC/Cr, and SiC/NiCr were also studied. The reactions were carried out in air with the materials, in the shape of discs, maintained in contact under a pressure of 7 MPa. A reaction was detected with SiC and the model alloy at all temperatures studied, and the reaction was diffusion controlled with an activation energy of 184 kJ/mole. In the ceramic the reaction was dominated by the diffusion of Ni into the ceramic forming a banded structure consisting of alternating layers of δ-Ni_2Si and a two phase mixture of graphite and δ. On the metal side, the reaction was very dependent on the presence of alloying elements, with pure Ni reacting to the greatest extent, followed by the binary NiCr alloy, and finally by NiCrAl. The growth and presence of the phases detected in these reactions is consistent with phase equilibria concepts.

4999 On the portevin-Le Chatelier effect due to Snoek strain aging in the niobium oxygen system. Park, S.C.; Beckerman, L.P.; Reed-Hill, R.E. (Department of Materials Science and Engineering, University of Florida, Gainesville, FL 32611). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 463-470(Mar 1983). Contract AS05-76ER03262.

Dynamic strain aging in niobium containing between 0.01 and 0.95 at. pct oxygen was investigated between 77 and 971 K using a nominal strain rate of 8.8 X 10^{-5} s^{-1}. At higher oxygen concentrations both type A and type B serrations were observed between 355 and 422 K. It is proposed that all of this serrated flow is due to Snoek dynamic strain aging. This is supported by the appearance of th serrations at much lower temperatures than those normally associated with Cottrell strain aging an the observation that the time between the type A serrations on a stress strain curve equals the jump time of an oxygen atom. Strain rate sensitivity

measurements were consistent with the generally accepted view that serrations occur only when the strain rate sensitivity becomes sufficiently negative.

5000 **Improvement in lower temperature mechanical properties of 0.40 Pct C-Ni-Cr-Mo ultrahigh strength steel with the second phase lower bainite.** Yoshiyuki, T.; Kunio, O. (Department of Metallurgical Engineering, College of Engineering, University of Osaka Prefecture, Sakai, Osaka 591). *Metallurgical Transactions, [Section] A: Physical Metallurgy and Materials Science;* **14A**: 485-499(Mar 1983).

A study has been made of the effect of the second phase lower bainite on lower temperature mechanical properties from ambient temperature (287 K) to 123 K of a commercial Japanese 0.40 pct C-NiCr-Mo ultrahigh strength steel corresponding to AISI 4340. When 25 vol pct lower bainite, which appeared in acicular form so as to partition prior austenite grains, was associated with martensit at 473 K, it provided a better combination of strength and ductility than that achieved using 1133 K direct water quenching irrespective of the test temperature. With the lower bainite, notch tensile strength was dramatically improved over the temperature region studied about 2150 MPa even at 123 K; whereas, in the case of 1133 K direct water quenching, it remained at about 1700 MPa. Similar trends were observed in the relationship between the lower bainite and the Charpy V-notch impact energy at and above 238 K. The lower bainite also produced superior fracture ductility and notch toughness results with decreased temperature of testing as compared to those obtained using a $\gamma \rightleftharpoons \alpha'$ repetitive heat treatment for the same steel. The above beneficial effects of the second phase lower bainite on lower temperature mechanical properties are briefly discussed in terms of metallographic examinations, the law of mixtures, and so on.

5001 **The influence of trace additions of zirconium on diffusional creep in Ni-20% Cr.** Schneibel, J.H.; Petersen, G.F. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Scripta Metallurgica;* **17**: No. 3, 353-358(Mar 1983). Contract W-7405-ENG-26.

The usefulness of nickel base alloys in high temperature structural applications is sometimes limited by low creep ductilities. Creep ductilities in turn may be significantly influenced by trace element additions and residual impurities. For example, creep fracture strains in nickel can be substantially reduced by small amounts of antimony and the creep ductility of Ni-20% Cr can be greatly improved by additions of zirconium. Holt and Wallace suggest a number of ways in which a beneficial element like zirconium might influence creep fracture characteristics. Zirconium might prevent the agglomeration of carbides at the grain boundaries and thus remove potential sites for intergranular cracking or cavitation, remove detrimental sulfur and carbon fro the grain boundaries by forming zirconium-sulphides or zirconium-carbosulphides, or segregate to the grain boundaries and slow down grain boundary diffusion. One of the three possibilities listed above, namely, the effect of zirconium additions on diffusion along the grain boundaries, is examined in the present paper. Coble creep was selected as a convenient experimental technique to do this. In order to simplify the experiments, high purity alloys with low precipitate and inclusion contents were employed. The effect of zirconium on carbide agglomeration suggested above is therefore not important in the present experiments and need not be considered in their interpretation.

5002 **Hydrogen permeation and diffusion in niobium.** Sherman, R.; Birnbaum, H.K. (Southwest Research Institute, San Antonio, TX 78284). *Metallurgical Transactions, [Section] A: Physical Metallurgy and Materials Science;* **14A**: 203-210(Feb 1983). Contract AC02-76ER01198.

High temperature hydrogen permeation experiments were performed on niobium using ultra high vacuum techniques in an attempt to maintain clean specimen surfaces. Diffusivities and permeabilities were measured from 700 K to about 1400 K at hydrogen pressures ranging from 4.26 Pa to about 0.013 Pa. The measured diffusivities are in agreement with values extrapolated from the low temperature surface independent measurements. In contrast to low temperature measurements, a trend indicating a classical isotope effect is observed for hydrogen and deuterium diffusivities in niobium at the higher temperatures. The measured hydrogen permeation constants agree with independent solubility and diffusivity measurements and are characterized by a negative enthalpy, as expected from low temperature solubility and diffusivity measurements. These results are contrasted with previou measurements which appear to have been controlled by surface reactions.

5003 **Influence of sulfur, phosphorus, and antimony segregation on the intergranular hydrogen embrittlement of nickel.** Bruemmer, S.M.; Baer, D.R.; Jones, R.H.; Thomas, M.T. (Battelle Pacific Northwest Laboratory, P.O. Box 999, Richland, WA 99352). *Metallurgical Transactions, [Section] A: Physical Metallurgy and Materials Science;* **14A**: 223-232(Feb 1983). Contract AC06-76RL01830.

The effectiveness of sulfur, phosphorus, and antimony in promoting the intergranular embrittlement of nickel was investigated using straining electrode tests in 1N H_2SO_4 at cathodic potentials. Sulfur was found to be the critical grain boundary segregant due to its large enrichment at grain boundaries (10^4 to 10^5 times the bulk content) and the direct relationship between sulfur coverage and hydrogeninduced intergranular failure. Phosphorus was shown to be significantly less effective than sulfur or antimony in inducing the intergranular hydrogen embrittlement of nickel. The addition of phosphoru to nickel reduced the tendency for intergranular fracture and improved ductility because phosphoru segregated strongly to grain interfaces and limited sulfur enrichment. The hydrogen embrittling potency of antimony was also less than that of sulfur while its segregation propensity was considerably less. It was found that the effectiveness of segregated phosphorus and antimony in prompting inter granular embrittlement vs that of sulfur could be expressed in terms of an equivalent grain boundary sulfur coverage. The relative hydrogen embrittling potencies of sulfur, phosphorus, and antimony are discussed in reference to general mechanisms for the effect of impurity segregation on hydrogeninduced intergranular fracture.

5004 **Mechanisms of intergranular cavity nucleation and growth during creep.** Goods, S.H.; Nieh, T.G. (Sandia National Laboratories, Livermore, CA 94550). *Scripta Metallurgica;* **17**: No. 1, 23-30(Jan 1983). Contract AC04-76DP00789.

It is generally recognized that creep-rupture of metals and alloys is caused by the formation, growth and coalescence of grain boundary cavities. A large body of literature suggests that the nucleation of cavities rather than their growth controls the fracture of materials over a wide range of temperatures, especially at temperatures associated with creep deformation. Thus when cavities such as voids or gas bubbles exist in materials prior to the beginning of deformation a severe loss in creep ductility often results. Because cavities are such a potent source of embrittlement, a great many studies have attempted to illustrate both experimentally and theoretically the role of cavity growth in the creep fracture process. However, understanding the effect of grain boundary cavities on creep fracture is complicated by the inability to accurately characterize the cavity structure prior to the onset and during creep deformation. For materials in which cavitation, the simultaneous nucleation and growth of cavities, occurs continously during creep, the kinetics of cavity growth are often obscured by the kinetics of cavity nucleation. In order to understand the importance of either cavity nucleation or growth in creep fracture, the nucleation event must be clearly and unambiguously separated from cavity growth processes. In this article the critical factors which must be considered in the study of creep cavitation are discussed. The authors first examine a number of key observations regarding the processes responsible for cavity nucleation, then discuss the importance of nucleation in creep fracture and conclude with an analysis of important theoretical and experimental results found in the recent literature which illustrate the micromechanics of cavity growth.

5005 **Mechanical properties of silver at low temperatures.** Logan, R.W.; Castro, R.G.; Mukherjee, A.K. (Materials Science Division, Lawrence Livermore National Laboratory, Livermore, California 94550). *Scripta Metallurgica;* **17**: No. 1, 63-66(Jan 1983). Contract W-7405-ENG-48.

In this study the authors obtained detailed information about the stress, strain, strain rate, and temperature-dependence of plastic flow in cold-worked high-purity (99.99 wt%) silver. They performed tensile and creep tests at temperatures from 77 K to 473 K and at strain rates of 10^{-8} to 10^{-3} per second. It is generally agreed that silver, like most facecentered-cubic metals, deforms at low temperatures by the dislocation intersection mechanism. The rate-controlling process in the intersection mechanism is the overcoming of obstacles (forest dislocations) by glide dislocations. The process involves the formation of jogs and constrictions, with an activation energy appropriate to those processes. The amount of local deformation per successful event is expressed by an activation volume, or activation area times the Burgers vector. As the density of the forest increases--at higher strains and lower temperatures--the activation area is expected to decrease. At temperatures near half the absolute melting point (617 K) the metal begins to deform predominantly by climb-controlled dislocation creep. The data generated thus far show some interesting phenomena concerning the transition between these two mechanisms.

5006 **On the controlling parameters for fatigue-crack threshold at low homologous temperatures.** Yu, W.; Gerberich, W.W. (Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, MN 55455). *Scripta Metallurgica;* **17**: No. 1, 105-110(Jan 1983). Contract AC02-79ER10433.

Fatigue crack propagation phenomena near the threshold stress intensity level ΔK /SUB TH/ , has been a vigorously studied topic in recent years. Near threshold the crack propagates rather slowly, thus giving enough time for various physical and chemical reactions to take place. Room air, which is the most commonly encountered environment, can still supply various ingredients such as oxygen, water vapor (and thus hydrogen) to support these reactions. Much effort had been directed toward the environmental aspects of near threshold fatigue crack growth. By conducting tests under vacuum, Suresh and coworkers found that the crack propagation rate in a 2-1/4 Cr-1Mo steel was higher in vacuum than in air. An oxide induced closure, which served to reduce the effective stress intensity at the crack tip, seems to furnish a good explanation. Neumann and coworkers proposed that during the fatigue process, extrusion-intrusion pairs can develop as a consequence of reversed slip around the crack tip when the crack was propagated near threshold stress intensity. Beevers demonstrated that fatigue fracture surfaces contact each other during unloading even under tension-tension cycling. Kanninen and Atkinson also reached the conclusion that the compressive stress acting at the crack tip due to residual plasticity can induce closure. Microstructural effects have also been cited as important factors in near threshold crack growth. It is generally accepted that coarser grains have a beneficial effect on the resistance to the near threshold crack propagation.

5007 **Mechanisms of cavity growth in creep.** Chen, I.W. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Scripta Metallurgica;* **17**: No. 1, 17-22(Jan 1983). Contract AC02-77ER04461.

The growth of intergranular cavities under creep conditions is of considerable technological interest. However, the phenomenon is complex. First, kinetic and mechanical processes at elevated temperature are many. Second, the size distribution of cavities, being a function of time, varies from one grainboundary to the other due to the heterogeneous and continuous nucleation of new cavities. Third, the orientation and the surroundings of each grain-boundary is different, giving rise to a broad spectrum of growth conditions of different mechanical descriptions. These considerations result in an almost infinite number of cases which are too numerous to analyze deterministically. For a mechanistic understanding, certain idealizations have to be made. This paper attempts to give an up-to-date account of such understanding, with the necessary idealization, and to point out the deficiencies in the simplified picture in each case. As an outline, the authors pose the following three problems in the order of increasing complexity. The simplest case pertains to cavitation on the transverse grain-boundary in a bicrystal under a normal stress. The second idealized case deals with cavitation on transverse boundaries in a polycrystal. The third case deals with inclined boundaries when the additional component of grain-boundary sliding sometimes causes "anomalous" effects.

5008 **Thermal diffuse scattering in β-phase Cu-AL-Ni alloy.** Dyorack, M.A.; Chen, H. (Dept. of Metallurgy and Mining Engineering and the Materials Research Laboratory, University of Illinois at Urbana-Champaign Urbana, IL 61801). *Scripta Metallurgica;* **17**: No. 1, 131-134(Jan 1983).

The alloy Cu-Al-Ni with concentration near Cu_3Al exhibits an order-disorder transition from the disordered bcc β-phase to the ordered fcc β_1-phase of the DO_3 type at high temperature. The ordered β_1-phase remains stable at room temperature upon quenching from the high temperature β-phase. At lower temperature, the β_1-phase again undergoes a martensitic transition to the orthorhombic γ'-phase. Recent elastic constant measurements have shown considerable lattice softening. Additional evidence for the lattice softening was obtained from inelastic neutron scattering experiments in which the TA_2 phonon mode showed low frequencies. This low energy TA_2 mode should also manifest itself in a diffraction experiment by exhibiting non-radial diffuse streaks satisfying certain geometrical extinction conditions. However, it can be argued that static displacements of similar amplitude to that of the TA_2 phonon mode resulting from defects or sublattice ordering could also account for the extinction conditions seen. The purpose of this work is to examine the diffuse scattering streaks by absolute x-ray intensity analysis at room temperature and at elevated temperatures. This study is intended to provide solid experimental evidence which verifies that the diffuse streaks occurring in a β-phase Cu-Al-Ni alloy are dynamical in nature. In addition, the phonon behavior as a function of temperature is examined.

5009 **STEM analysis of primary austenite solidified stainless steel welds.** Brooks, J.A.; Thompson, A.W.; Williams, J.C. (Sandia National Laboratories, Livermore, CA 94550). *Metallurgical Transactions, [Section] A: Physical Metallurgy and Materials Science;* **14A**: 23-32(Jan 1983). Contract AC04-76DP00789.

Scanning transmission electron microscopy (STEM) of welds in Fe-Ni-Cr ternary alloys was used to study the nature of partitioning during primary austenite solidification. It was found that concentration profiles obtained by STEM analysis can be used to distinguish between primary ferrite and primary austenite solidified weld structures. Measured alloy concentrations within the cellular structure were also used to estimate the solidification path and tie lines for solidification by primary austenite.

5010 **Intergranular cavitation in creeping alloys.** Argon, A.S. (Massachusetts Institute of Technology, Cambridge, MA 02139). *Scripta Metallurgica;* **17**: No. 1, 5-12(Jan 1983). Contract AC02-77ER04461.

Fracture at high temperature in structural alloys can be of several forms. Of these, the only one of interest here is the intergranular form of fracture that occurs under usual service stresses and takes a relatively long time to develop. This fracture goes through several stages, starting with nucleation of cavities along grain boundaries, followed by their growth by coupled diffusional flow and creep flow under conditions of gradual load shedding, leading to the development of quasi-homogeneously accumulated grain boundary facet cracks, without or with eventual macro-crack evolution before final fracture. The subject has seen active development during the past decade which, however, has not always led to a general consensus on the nature of the specific processes and their representation. The mechanistic details of intergranular fracture in creeping alloys have recently been critically assessed by Argon. Here the authors are interested in the mechanisms of cavity nucleation and growth.

5011 **Predicting sequence effects and cumulative damage in fatigue using a unified model for crack initiation and growth.** Miller, A.K. (Dept. of Materials Science and Engineering, Stanford Univ., Stanford, CA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP.-VOL. 71**: 21-44(1983). (CONF-830607—). Contract AT03-76ER70057.

A new unified fatigue model which covers both crack initiation and crack growth has been used to predict load sequence effects in fatigue failure of 7075-T6 aluminum subjected to two-level loading histories. Dubbed "FATIGMOD," the model simulates fa-

tigue as the successive failure of elements within, and on the surface of, a material; failure of each element occurs when the local variables at that element reach any one of the three failure criteria, which are formulated in terms of local accumulated plastic work density, local tensile stress, and local tensile strain. For "smooth" (i.e., unnotched and non-precracked) specimens, FATIGMOD predictions indicate that a "high-low" load sequence results in a cycle fraction sum at failure which is smaller than unity, while a "low-high" load history produces the reverse behavior. In contrast, the cycle fraction sum at failure for a precracked specimen is predicted to exceed unity in a stress reduction test but is less than one in a test with stress increases. These predictions are in good agreement with experimental results. The effects of load sequence on fatigue damage are explained in terms of the curves of crack length vs. number of cycles generated by the unified model. The predicted curves for fatigue and the resulting cumulative damage behavior are compared with those observed in stress corrosion cracking and creep rupture.

5012 **Atomic resolution observations of solute atom segregation to stacking faults in a Co-0.96 at.% Nb alloy.** Herschitz, R.; Seidman, D.M. (Cornell Univ., Bard Hall, Dept. of Materials, Science and Engineering and the Materials Science Center, Ithaca, New York). *Scripta Metallurgica;* **16**: No. 7, 849-854(Jul 1982).

The authors present the results of an atom-probe field-ion microscope (FIM) study of niobium segregation to stacking faults in a Co-0.96 at % Nb alloy. Their atom-probe FIM allows them to determine the chemical identity of individual atoms with a mass (m) resolution of ($\Delta m/m$ about1/200 (6-9). In addition, the atom-probe FIM has a lateral atomic resolution, for composition, of a few angstroms and therefore it is an ideal tool for studying solute segregation to stacking faults.

5013 **Region 1 controversy in superplastic Zn-22 wt% Al.** Logan, R.W. (Materials Science Division, Lawrence Livermore National Laboratory, Livermore, CA 94550). *Scripta Metallurgica;* **16**: No. 7, 845-847(Jul 1982). Contract W-7405-ENG-48.

In all recent studies on Zn-22 wt% Al, a low strain-rate Region I with $n \simeq 3$ has been observed. Correcting for concurrent grain growth will change $n \simeq 4.1$, as reported by Mohamed et al., to $n \simeq 3.4$, consistent with other work. Possible premature measurement of strain rate in the work of Vaidya et al. does not invalidate their $n = 1$ findings, since $n \simeq 3$ has been observed in other studies at the same strain levels. Recent reports of $n = 1$ in Zn-22 wt% Al at constant torsional velocity must be questioned because of the extremely small loads involved.

5014 **Analysis of a cooperative model of hydrogen diffusion in a transition metal.** Lee, M.H.; Bannerjee, S. (Univ. of Georgia, Athens). pp 141-153 of Metal-hydrogen systems. Veziroglu, T.N. (ed.). Oxford, England; Pergamon Press (Mar 1982). Contract AS09-77ER01023.

From Miami International Symposium on Metal-Hydrogen Systems; Miami Beach, FL, USA (13 Apr 1981).

A cooperative lattice model appropriate for describing hydrogen diffusion in the dense hydrogen phases of a metal-hydrogen system is developed. The model incorporates the hard-core interaction between hydrogen atoms and also some interaction between the interstitial hydrogen and the metal lattice. Unlike other lattice models, our model treats hydrogen transitions as its main source of energy. It is thus a nonrigid quantum lattice fluid model for interstitial hydrogen diffusion. Under a proper transformation, the model may be shown to have a magnetic analog. It is equivalent to magnetic systems of biquadratic exchange featuring both dipolar and quadrupolar ordering. Such systems are known to have first and second order phase transitions and also a tricritical point. Our model supports mean-field-like critical behavior if indirect forces between interstitial hydrogen atoms are long-ranged and approximately constant. Within the constant coupling approximation, the critical temperature is independent of the isotopic mass.

5015 **Thermal stability data of amorphous binary alloys.** Wang, R. (Pacific Northwest Lab., Richland, WA). *Bulletin of Alloy Phase Diagrams;* **2**: No. 3, 269-280(1981).

Data on the thermal stability of amorphous (glassy) binary alloys are compiled. Where available, alloy preparation method, crystallization temperature and method of measurement of crystallization temperature are tabulated. Other relevant aspects such as crystallized phases and compositions, glass transition temperature and analytical parameter variations also are given when data are available.

5016 **Structure determinations on Sb up to 85 x 10^2 MPa.** Schiferl, D. (Los Alamos Scientific Lab., NM); Cromer, D.T.; Jamieson, J.C. *Acta Crystallographica;* **B37**: 807-810(1981).

High-pressure single-crystal structure determinations were performed on Sb in the A7 crystal structure type in the pressure range 63 to 85 x 10^2 MPa. The A7 structure initially approaches simple cubic, but then levels off. The transition from the A7 to the primitive simple-cubic structure, which was reported to occur in this pressure range by some previous workers, was not found. A transition to an undetermined structure was found at 86 x 10^2 MPa, a transition pressure reported by several workers.

5017 **The Ag-V (silver-vanadium) system.** Smith, J.F. (Iowa State Univ., Ames). *Bulletin of Alloy Phase Diagrams;* **2**: No. 3, 343-344(1981). Contract W-7405-ENG-82.

The composite evidence indicates that the V-Ag system exhibits immiscibility in both solid and liquid states, and the terminal solubilities are likely to be small to negligible in both solid and liquid states to temperatures of 2500°C or more.

5018 **Disintegration of liquid metals by low pressure water blasting.** Heshmatpour, B.; Copeland, G.L. (Oak Ridge National Lab., TN). *International Journal of Powder Metallurgy and Powder Technology;* **17**: No. 3, 213-220(1981). Contract W-7405-ENG-26.

The feasibility of disintegrating metals by a low cost system and subsequently incorporating them into grout mixtures has been demonstrated. A low pressure water blasting technique consisting of multiple nozzles and a converging-line jet stream was developed to disintegrate liquid metals and produce coarse metal powder and shot. Molten iron resulted in spherical shot, while copper, aluminum, and tin produced irregular shaped particles. The particle size was between 0.05 and 3 mm (0.002 and 0.1 in.), and about half the particles were smaller than 1 mm (0.04 in.) in all cases. The water consumption was rather low, while the production rate was relatively high. The method proved to be simple and reliable. The coarse metal powders were suspendable in grout fluids, indicating that they are probably disposable by the shale hydrofracture technique.

3602 Ceramics, Cermets, And Refractories

REFER ALSO TO CITATION(S) 4474, 5534

5019 **(CONF-821145—6) Development of thermal-shock-resistant refractories.** Diercks, D.R.; Dusek, J.T. (Argonne National Lab., IL (USA)). Aug 1982. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE84003628.

From 7. materials for coal conversion and utilization conference; Gaithersburg, MD, USA (16 Nov 1982).

$MgCr_2O_4$ was selected as the model refractory, with additions of ZrO_2, $FeCr_2O_4$, W, and Mo. Sintering runs were made. (DLC)

5020 **(CONF-831174—24) Dependence of the deformation of Mn/sub 1-δ/O on the deviation from stoichiometry.** Routbort, J.L. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01. Order Number DE84003568.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

The stress-strain behavior of <100> single crystals of Mn/sub 1-δ/O has been measured for the first time. The experiments were performed at 1200°C varying the oxygen partial pressure P/

sub O_2/ from 10^{-12} to 10^{-5} atms which causes the deviation from stoichiometry δ to vary between 5 x 10^{-2} to 2%. The upper yield stress and the stress achieved at a zero work-hardening rate vary by a factor of 2 as a function of δ and exhibit a maximum at P/sub O_2/ ~ 10^{-9} atms. Results suggest that the diffusion of oxygen interstitials control deformation for large δ while oxygen vacancies control deformation for small δ, an interpretation used to explain the deformation Co/sub 1-δ/O. These results illustrate the intimate relationship between defect properties and deformation in nonstoichiometric oxides.

5021 **(CONF-831199—2) Corrosion of refractories in synthetic coal slags.** Greenberg, S.; Poeppel, R.B.; Chen, J. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01. Order Number DE84003616.

From 3. Electric Power Research Institute annual contractors' conference on coal gasification; Palo Alto, CA, USA (2 Nov 1983).

The effects of slag temperature and slag velocity on the corrosion of chromia-containing refractories were studied in a rotating-cylinder test furnace. In this furnace, 1-in.-diameter x 1-in.-high refractory cylinders are rotated at a controlled velocity (50 to 150 rpm) in slag of known composition, under controlled temperature (1500 and 1600°C) and oxygen partial pressure (~ 10^{-9} atm) conditions. Refractories containing 60 to 80% Cr_2O_3 showed negligible corrosion at 1500°C. At 1600°C, significant differences between refractories of similar composition were apparent, particularly at high rotational speeds. Subtle mineralogical differences among the various high-chromia refractories are the apparent cause of the differences in corrosion rates. Low-chromia (10% Cr_2O_3) refractories showed greatly accelerated corrosion rates in comparison with the high-chromia refractories. In a complementary study, the rotating-cylinder test furnace was modified to enable measurement of the viscosity of slags as functions of composition, temperature, and oxygen partial pressure. The results indicate that, in general, sensitivity of viscosity to oxygen partial pressure increases with increasing iron concentration in the slag. Published correlations are, in general, not applicable to the slags investigated in this study. Under the conditions of equilibrium achieved in this study, no hysteresis effects were observed.

5022 **(LBL—16526) Mechanical response of ceramics to creep loading.** Blumenthal, W.R. (Lawrence Berkeley Lab., CA (USA)). Aug 1983. Contract AC03-76SF00098. 95p. NTIS, PC A05/MF A01. Order Number DE84003896.

Thesis.

The mechanical response of small, semi-elliptical, identification-induced surface cracks in fine-grain alumina was studied. The deformation behavior of the crack tip region was monitored using crack opening and surface displacements. Results indicate values of the secondary creep exponent, n, between 1.5 and 2 with a temperature dependence consistent with secondary creep data from the same material. Crack growth was measured at 1300 and 1400°C and a narrow power-law growth regime was revealed. Again the power-law exponent and activation energy were very close to creep values. Asymptotic behavior was exhibited near both K/sub Ic/ and K/sub th/, the crack growth threshold. The threshold occurred near 0.4 K/sub Ic/, independent of temperature. Crack tip damage in the form of grain boundary cavities growing by diffusion was responsible for crack extension. The damage also exerts a strong influence on the displacement field as predicted by recent theories. The crack growth threshold is preceded by a transition in the size and distribution of damage. At K/sub I/ near K/sub Ic/ the damage is restricted to a few facets directly ahead of the crack tip. Near K/sub th/ damage concentrates in side-lobes far ahead of the crack tip and at angles between 20° to 60° from the plane of the crack. The transition between frontal and side-lobe damage is anticipated to be moderately dependent on grain size. 34 figures.

5023 **(N—8327031) The beneficiation of power station coal ash and its use in heavy clay ceramics.** Anderson, M.; Jackson, G. (UKAEA Atomic Energy Research Establishment, Harwell). Jan 1983. 21p. (AERE-R—10806; HL—83/146(C14)). NTIS, PC A02/MF A01.

Differences in the carbon content and the bulk density of pulverized fuel ash produced by coal-burning electric power plants, and the magnitude of these variations are considered. The influence of out-of-the-hopper material on the properties of the ash/clay mixes is examined and methods for overcoming the problem are addressed. The operation of boilers in a power station is outlined in an effort to explain the inherent short-run variability of ash.

5024 **(PNL-SA—10758) Effect of flow rate on the leaching of nuclear waste glasses.** Strachan, D.M. (Pacific Northwest Lab., Richland, WA (USA)). Sep 1983. Contract AC06-76RL01830. 15p. (CONF-830451—27). NTIS, PC A02/MF A01. Order Number DE84003356.

From American Ceramic Society annual meeting; Chicago, IL, USA (25 Apr 1983).

Results from a long-term, continuous-flow leach test (MCC-4) are discussed in detail to illustrate some of the effects of flow rate on the leach rate of nuclear waste glass. From the results it can be concluded that for SRL-131 glass, and perhaps all nuclear waste glasses, the leach rate of specific elements as measured by their appearance in solution is not necessarily a measure of the corrosion rate of the glass. The rate at which an element appears in solution in a leach test, both static and dynamic, appears to depend upon the kinetics of precipitation and dissolution of an alteration phase when such a phase forms. An element which can be demonstrated not to sorb or precipitate can be used to obtain kinetics information on the behavior of the glass matrix. In the simple model presented here the rate of dissolution under dynamic conditions is proportional to the forward rate of reaction (dissolution) and the degree of undersaturation. As flow rate is increased lower concentrations of the individual elements are observed in solution so long as the other variables remain constant. However, for elements which can precipitate or sorb the composition of the leach solution plays an important role in the behavior of that element. Prediction of the behavior of any given element is difficult at best but the use of a geochemical code may simplify the prediction of solubility and sorption controls. Glass may dissolve by a simple mechanism which appears complex because of complex chemistry that occurs in the system. Hence, any leach model must contain at least the major chemical reactions which occur in the system.

5025 **(PNL-SA—11504) Microstructure and phase composition of sputter-deposited zirconia-yttria films.** Knoll, R.W.; Bradley, E.R. (Pacific Northwest Lab., Richland, WA (USA)). Nov 1983. Contract AC06-76RL01830. 10p. (CONF-831174—19). NTIS, PC A02/MF A01. Order Number DE84003352.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

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Thin ZrO_2-Y_2O_3 coatings ranging in composition from 3 to 15 mole % Y_2O_3 were produced by rf sputter deposition. This composition range spanned the region on the equilibrium ZrO_2-Y_2O_3 phase diagram corresponding to partially stabilized zirconia (a mixture of tetragonal ZrO_2 and cubic solid solution). Microstructural characteristics and crystalline phase composition of as-deposited and heat treated films (1100°C and 1500°C) were determined by transmission electron microscopy (TEM) and by x-ray diffraction (XRD). Effects of substrate bias (0 ~ 250 volts), which induced ion bombardment of the film during growth, were also studied. The as-deposited ZrO_2-Y_2O_3 films were single phase over the composition range studied, and XRD data indicated considerable local atomic disorder in the lattice. Films produced at low bias contained intergranular voids, pronounced columnar growth, and porosity between columns. At high bias, the microstructure was denser, and films contained high compressive stress. After heat treatment, all deposits remained single phase, therefore a microstructure and precipitate distribution characteristic of toughened, partially stabilized zirconia appear to be difficult to achieve in vapor deposited zirconia coatings.

5026 **(SAND—83-1291C) Densification of shock-treated aluminum nitride and aluminum oxide.** Beauchamp, E.K.; Graham, R.A.; Carr, M.J. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 9p. (CONF-831174—26). NTIS, PC A02/MF A01. Order Number DE84003251.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

The structures of aluminum nitride and aluminum oxide powders have been modified by explosive shock treatment at pressures from 4 to 27 GPa. Shock-induced dislocations in AlN were apparently responsible for enhancement in hot pressing behavior. In Al_2O_3 an increase of 3 to 4 times in densification rates after shocking resulted from rapid sintering of aggregates in the powder.

5027 **(SAND—83-1422C) Metallic microwave conductivity in shock-loaded rutile.** Venturini, E.L.; Graham, R.A. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 8p. (CONF-831174—15). NTIS, PC A02/MF A01. Order Number DE84002174.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

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Electron spin resonance (ESR) has been used to characterize the paramagnetic defects present in both single crystal and powder rutile (TiO_2) subjected to explosive shock loading and preserved for post-shock study. The Ti^{+3} defect concentration produced by the shock process is an order of magnitude larger than values reported for vacuum-reduced rutile. The ESR lineshape is characteristic of a conducting material, and the estimated microwave resistivity in the shock-loaded powder is more than an order of magnitude lower than the minimum dc value measured in vacuum-reduced rutile. It appears that shock-wave loading leaves the rutile in a defect state not achieved in prior work.

5028 **(SwRI—7054) Characterization and analysis of cavity development during creep of ceramics at elevated temperature. Progress report for 1983.** Page, R.A.; Lankford, J. Jr. (Southwest Research Inst., San Antonio, TX (USA)). 15 Oct 1983. Contract AS05-82ER12044. 100p. NTIS, PC A05/MF A01. Order Number DE84003113.

The early stages of creep cavitation in sintered alumina are characterized using small angle neutron scattering (SANS). It is found that the initial cavity density is on the order of 10^{11} cm^{-3}, and that the average initial pore is aproximately 60 nm in radius. The incubation time for nucleating additional pores during subsequent creep is extremely short, in agreement with theory based on the precipitation of grain-boundary diffusing vacancies. Pore density at constant stress and temperature is a linearly increasing function of time, again as predicted by classical nucleation theory. However, a local stress of 10^{-2} E is required to achieve the measured nucleation rate. Cavities are observed to lie primarily on two-grain junctions in linear arrays, with an average cavity radius of approximately 60 nm. It is hypothesized that the cavities nucleate at grain boundary ledges which provide the necessary local stress concentrations. Calculation of the individual cavity growth rate yields a zero or near zero value. This suggests a rapid transient growth period following nucleation which quickly decreases to a negligible growth rate.

5029 **Partial molar volumes of hydrogen and deuterium in niobium, vanadium, and tantalum.** Peterson, D.T.; Herro, H.M. (Department of Materials Science and Engineering and the Ames Laboratory-USDOE, Iowa State University, Ames, IA 50011). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **14A**: 17-21(Jan 1983). Contract W-7405-ENG-82.

The partial molar volumes of hydrogen and deuterium were measured in vanadium, niobium, and tantalum by a differential pressure technique. One-half of an electrolytically charged sample plat was compressed between hardened steel blocks in a hydraulic press. The activity of hydrogen in the hig pressure region was raised and caused hydrogen to diffuse into the low pressure region. The partia molar volume was calculated from the ratio of the hydrogen concentrations in the high and low pressure regions of the sample. Small isotope effects were found in the partial molar volume. Hydrogen had the larger volume in niobium and tantalum, but the reverse was true in vanadium.

3603 Composite Materials

REFER ALSO TO CITATION(S) 4646

5030 **(CONF-831142—1) Transformation toughened and whisker reinforced ceramics.** Becher, P.F.; Wei, G.C. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01. Order Number DE84003281.

From Automotive technology development contractor coordination meeting; Dearborn, MI, USA (13 Nov 1983).

Studies of transformation toughened alumina ceramics containing dispersions of zirconia particles have led to the development of high tensile strength (up to 1000 MPa, ~ 150,000 psi as measured in a four-point flexure test) Al_2O_3-ZrO_2 composite materials with K/sub IC/ values (8 to 13 MPa.m/sup 1/2/) which are two- to threefold greater than those of the toughest conventional ceramics. In addition, these composites exhibit much better resistance to static fatigue than do alumina ceramics. Development of SiC whisker reinforced oxide ceramic composites has also resulted in composites with fracture toughness values of up to 9 MPa.m/sup 1/2/ (Al_2O_3-20 vol % SiC whiskers). These studies indicate that the toughening process involves a whisker pullout mechanism. This toughening process is also activated during slow crack growth (fatigue) and, hence, substantially increases the slow crack growth resistance of the composite.

5031 **(UCRL—89646) Application of kinetic fracture mechanics to life prediction for polymeric materials.** Christensen, R.M.; Glaser, R.E. (Lawrence Livermore National Lab., CA (USA)). 2 Nov 1983. Contract W-7405-ENG-48. 17p. (CONF-831111—11). NTIS, PC A02/MF A01. Order Number DE84003002.

From ASME winter annual meeting; Boston, MA, USA (13 Nov 1983).

A recently developed theory of kinetic crack growth is applied to the problem of the time-dependent failure of polymeric materials subject to a timewise constant state of stress. The theory is generalized to include a rather complete treatment of statistical variability. When restricted to the power law range of behavior, it is found that an assumption of a Weibull distribution of static strengths implies rigorously that the corresponding lifetime distributions are also Weibully distributed. In fact, an extremely simple interrelation is found whereby the shape parameter for lifetime is equal to the product of the shape parameter for static strength times the magnitude of the log stress versus log lifetime slope of the scale parameter for the lifetime distribution. These theoretical predictions are compared with the experimental results available from the testing of a particular polymeric fiber composite material, Kevlar 49/epoxy. The theoretical prediction for the lifetime distribution compares favorably with the observed data.

5032 **An epoxy resin system for composite flywheels.** Chiu, I.L. (Univ. of California, Livermore); Kolb, J.R. *Composites;* **5**: 18-20(Spr 1983). Contract W-7405-ENG-48.

Results are presented from an effort to develop a resin system for a fiber reinforced composite flywheel than can operate at temperatures greater than 120 C. Attention is given to a simple, two-component epoxy resin system, the diglycidyl ether of bisphenol-A and methane diamine, which satisfactorily meets nearly all flywheel operation criteria. The resin is based on commercially available materials of low toxicity, and has the long pot life required of a resin system for filament-winding operations. Excellent tensile properties are maintained up to 125 C, even after 16 weeks at this temperature in an inert atmosphere, without sign of deterioration.

3606 Other Materials

REFER ALSO TO CITATION(S) 4446, 4473, 4481, 4866, 5122, 5152, 5346, 5591

5033 (BNL—33764) Neutron scattering study of MnSi proving no exchange hole. Uemura, Y.J.; Majkrzak, C.F.; Shirane, G.; Ishikawa, Y. (Brookhaven National Lab., Upton, NY (USA); Tohoku Univ., Sendai (Japan). Dept. of Physics). 1983. Contract AC02-76CH00016. 9p. (CONF-831187—9). NTIS, PC A02/MF A01. Order Number DE84002879.

From MMM conference; Pittsburgh, PA, USA (8 Nov 1983).

Neutron scattering experiments have been performed in MnSi below T/sub c/ with the double-axis powder scattering technique using unpolarized neutrons, and also with the polarization analysis technique. The magnetic scattering intensity has not shown any anomaly around $q = 0.5\ A^{-1}$, in contrast to the previous results of Ziebeck et al. who found a large intensity peak at this momentum transfer. Thus the hypothesis of Ziebeck et al. of observing an Exchange Hole is excluded.

5034 (BNL—33978) Photoemission studies of carbon overlayers on Nb. Krummacher, S.; Wesner, D.; Carr, R.; Strongin, M.; Sham, T.K.; Eberhardt, W. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA)). 1983. Contract AC02-76CH00016. 5p. (CONF-8310172—4). NTIS, PC A02/MF A01. Order Number DE84003264.

From Advances in soft x-ray science and technology conference; Upton, NY, USA (17 Oct 1983).

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We have studied the electronic properties of the amorphous, graphitic, and carbidic phases of carbon layers on niobium. While features of the valence band photoemission and absorption cross section spectra have been discussed in separate publications, this presentation focusses on the obervation of resonant photoemission and the photon-induced Auger spectra.

5035 (CONF-831174—22) Pulsed laser melting: the effect of implanted solutes on the resolidification velocity. Galvin, G.J.; Mayer, J.W.; Peercy, P.S. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science; Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 6p. NTIS, PC A02/MF A01. Order Number DE84003252.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Transient electrical conductance has been used to measure the resolidification velocity in silicon containing implanted solutes. Nonequilibrium segregation of the solutes occurs during the rapid resolidification following pulsed laser melting. The velocity of the liquid-solid interface is observed to depend on the type and concentration of the solute. A 25% reduction in solidification velocity is observed for an implanted indium concentration of three atomic percent. Implanted oxygen is also shown to reduce the solidification velocity. The dependence of the velocity on solute concentration impacts a variety of segregation, trapping and supersaturated solution studies.

5036 (DOE/ER/10598—4) Characterization of high temperature electrically conducting oxides. Anderson, H.U.; Sparlin, D.M. (Missouri Univ., Rolla (USA)). Nov 1983. Contract AC02-80ER10598. 14p. NTIS, PC A02/MF A01. Order Number DE84002887.

Goal was to study the relations between electrical conductivity, oxidation-reduction kinetics, defect structure, and composition of n- and p-type binary and ternary transition metal oxides. Thermogravimetric measurements, x-ray diffraction, transmission electron microscopy, electrical conductivity, electron paramagnetic resonance, and Seebeck measurements were conducted. The oxide systems studied were La-doped $SrTiO_3$, La-doped $BaTiO_3$, and Nb- and Ta-doped TiO_2. The electrical conductivity, carrier mobility, and defect concentration for several of the systems are discussed. The most important results were obtained for the $SrTiO_3$ and $LaCrO_3$ systems for which the oxygen activity and temperature stability ranges of the electrical conductivity are defined. It was also learned that the electron mobility in $SrTiO_3$ is not constant with carrier concentration.

5037 (INIS-mf—8471) Influence of atomic ordering on superconductivity and electric conductivity of A15 compounds with different valence electron density for heavy ion irradiated Nb_3Al, Nb_3Sn, Mo_3Ge, Mo_3Si and Mo-Re at low temperatures. Lehmann, M. (Erlangen-Nuernberg Univ., Erlangen (Germany, F.R.). Naturwissenschaftliche Fakultaet I - Mathematik und Physik). 9 Oct 1981. 195p. (In German). NTIS (US Sales Only), PC A09/MF A01. Order Number DE83703259.

Thesis (Ph.D.).

A15 compounds were studied using heavy ion Rutherford scattering, measurements of the transition temperature, electric conductivity and critical magnetic field. Radiation defects produced below 20 K by heavy ions are discussed, including anti-site-disorder effects. Annealing experiments were performed between 290 K and the transition temperature. The data are discussed in correlation with band structure effects and the theory of J. Appel (1976).

5038 (PNL-SA—11554) Leach testing of waste glasses under near-saturation conditions. Strachan, D.M.; Grambow, B. (Pacific Northwest Lab., Richland, WA (USA); Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). Nov 1983. Contract AC06-76RL01830. 11p. (CONF-831174—20). NTIS, PC A02/MF A01. Order Number DE84003353.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Two waste glasses, MCC 76 to 68 and C31 to 3, were leached in deionized water and 0.001 M $MgCl_2$ for periods up to 158 days. At 57 days the gel layer was removed from some of the specimens and leaching continued for up to 100 days. Results from leaching in deionized water showed that the gel layer was not protective. Results from leaching in 0.001 M $MgCl_2$ are in good agreement with the predicted results obtained from the use of the PHREEQE geochemical code and with sepiolite $[Mg_2Si_3O_8(OH)_4]$ as the Mg-bearing precipitate. Both B and Si were predicted and observed to increase with increasing glass dissolution while maintaining sepiolite solubility. Both MCC 76 to 68 and C31 to 3 glasses showed increased leaching in 0.001 M $MgCl_2$ upon removal of the layer. This suggests a leaching mechanism whereby leaching is driven by the formation of an alteration product.

5039 (SAND—83-1567C) Material properties of semiconductor strained-layer superlattices. Osbourn, G.C. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 10p. (CONF-831174—14). NTIS, PC A02/MF A01. Order Number DE84002103.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

High quality superlattices can be grown from semiconductor materials with lattice mismatches of several percent if the layers are kept sufficiently thin. The mismatch in these structures is accommodated by coherent layer strains, so that misfit defects are not generated at the superlattice interfaces. These strained-layer superlattices have unique structural, optical, and electrical properties due to both the large layer strains and the flexibility in the choice of lattice mismatched layer materials. Recent results which demonstrate the high crystalline quality of these mismatched heterostructures are reviewed. Further results are presented which illustrate some of the unique material properties of these structures, and potential applications associated with such properties are discussed.

5040 (SAND—83-7097) Modification of Bell Canyon Test (BCT) 1-FF grout. Final report. Buck, A.D.; Rhoderick, J.E.; Burkes, J.P.; Mather, K.; Reinhold, R.E.; Boa, J.A. Jr. (Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Structures Lab.). Sep 1983. Contract AC04-76DP00789. 56p. NTIS, PC A04/MF A01. Order Number DE84003525.

Bell Canyon Test (BCT) 1-FF grout was developed as a candidate material for use in repository sealing applications and was

actually used in two field tests in New Mexico. This grout and modifications of it were made in the laboratory and tested or examined for workability, compressive strength, restrained expansion, permeability, phase composition, and microstructure. Most of these were done to an age of 1 year. Compressive strength and expansion data were determined beyond this age (960 days). Modifications include use of three other cements, two other fly ashes, a silica fume, different water contents, and different amounts of expansive additive (plaster). Each cement and mineral admixture was characterized by conventional chemical and physical tests as well as by x-ray diffraction examination. In general, the results indicated that the modifcations to the basic BCT-1-FF grout produced other grouts that were as good as it. An exception to this was the grout mixture (M-8-C) made with shrinkage compensating expansive cement; it had an excessive flow time (>20 sec). Another grout mixture (M-9-C) also had excessive flow time and lower strength. It was thought that these problems could be solved with more modification to these two mixtures. 6 references, 24 figures, 7 tables.

5041 **(Y—2281) Specialty zinc oxide cements.** Holcombe, C.E. Jr.; Masters, D.R. (Oak Ridge Y-12 Plant, TN (USA)). 31 Oct 1983. Contract W-7405-ENG-26. 91p. NTIS, PC A05/MF A01. Order Number DE84003339.

Over 800 cements were evaluated to develop a fast-setting cement usable from -35° to 75°C. Reactive liquid mixtures were tested with zinc oxide. Six paste-type and one flowable cement compositions were developed. Tentative phase diagrams were constructed for reactive liquid systems. Cement characterization included x-ray diffraction, physical properties, morphology, and chemical resistance.

5042 **Method of doping a semiconductor.** Yang, C.Y.; Rapp, R.A. (to US Department of Energy). US Patent 4,392,928. 12 Jul 1983. Filed date 26 Jan 1982. vp.

A method is disclosed for doping semiconductor material. An interface is established between a solid electrolyte and a semiconductor to be doped. The electrolyte is chosen to be an ionic conductor of the selected impurity and the semiconductor material and electrolyte are jointly chosen so that any compound formed from the impurity and the semiconductor will have a free energy no lower than the electrolyte. A potential is then established across the interface so as to allow the impurity ions to diffuse into the semiconductor. In one embodiment the semiconductor and electrolyte may be heated so as to increase the diffusion coefficient.

5043 **Application of ion implantation and backscattering techniques to the analysis of nuclear waste glass corrosion.** Sales, B.C.; White, C.W.; Boatner, L.A. (Oak Ridge National Lab., TN (USA)). *Materials Letters;* **2**: No. 1, 1-5(Jul 1983).

Ion implantation and Rutherford backscattering depth profile analysis have been used to study changes in the near-surface composition of nuclear waste glasses that were corroded in aqueous media. The dissolution rate of the glass network during early stages of corrosion and effects of solution chemistry on the glass surface-layer composition were investigated. Properties of the altered layer were found to vary significantly as a function of the pH of the corroding solution.

5044 **The structure of second and third order twin boundaries in silicon.** Vaudin, M.D.; Ast, D.G.; Cunningham, B. (Department of Materials Science and Engineering, Cornell University, Ithaca, NY 14853). *Scripta Metallurgica;* **17**: No. 2, 191-198(Feb 1983). Contract AC02-76ER02899.

Symmetric second and third order twin boundaries in silicon have been observed using high resolution TEM. Micrographs of a symmetric (221)$\Sigma = 9$ boundary exhibited contrast feature consistent with the zig-zag dislocation structure proposed by Hornstra and similar to those reported in germanium. A model for a symmetric (529)$\Sigma = 27$ boundary was constructed and found to have the same periodicity and faceted structure as an experimentally observed $\Sigma = 27$ boundary. A system for modelling the structure of <110> tilt boundaries in tetrahedrally coordinated materials was developed based on the early work of Hornstra. Boundaries with (110) median planes and misorientations up to 70.53° were constructed using a repeating series of simple structural units.

5045 **Effects of radioactive radiation on concrete structure and strength. Final report on DFG research project Hi 227/16.** Seeberger, J.; Hilsdorf, H.K. Karlsruhe, Germany, F.R.; Karlsruhe University (1982). 81p. (In German). Library of Karlsruhe Univ. (T.H.) (Germany, F.R.).

Typical fluxes and minerals, hardened cement paste and mortar were irradiated at FR2, Karlsruhe. Changes in length were measured and X-ray diffraction studies, measurements of Young's modulus, and strength measurements were carried out. Fluxes and minerals could be characterized as follows: (a) Fluxes showing considerable radiation damage, e.g., granite which showed an elongation up to 1% and was completely destroyed. (b) Fluxes and minerals with little radiation damage, e.g., quarz, baryte, olivine, and serpentine. Changes in length in these materials will amount to 0.3 to 2.8 per mille. Compressive strength measurements of quartzite mortar showed that this elongation will not deteriorate the mechanical properties. (c) Fluxes and minerals without radiation damage, i.e., limestone, dolomite, feldspats, pyroxenes, hornblende, and magnetite. Studies on hardened cement paste of Portland cement, blast furnace cement limestone mortar and quartzite mortar showed no negative irradiation effects.

5046 **An electrochemical P-N junction etch-stop for the formation of silicon microstructures.** Jackson, T.N.; Tischler, M.A.; Wise, K.D. (Univ. of Michigan, Ann Arbor). *Electron Device Letters;* **EDL-2**: No. 2, 44-45(Feb 1981). Contract AC08-77DP04149.

An electrochemical technique allowing the protection of selected areas of silicon in ethylene diamine-based etchants is reported, and its application to the formation of silicon microstructures is described. Dissolution rates for passivated samples are less than 5 anstroms/minute, a factor of over 3000 times less than for unpassivated silicon.

5047 **Fatigue hardening of LiF single crystals in push-pull cyclic deformation.** Majumdar, B.S.; Burns, S.J. (Univ. of Rochester, NY). *Acta Metallurgica;* **29**: 425-436(1981).

The fatigue hardening response of LiF single crystals subjected to uniaxial cyclic deformation, at various strain amplitudes and strain-rates, has been related to the monotonic hardening rate. Cumulative strain in fatigue is obtained through Kocks' flow stress theory on a statistical distribution of obstacles. The difference between monotonic and cyclic deformation is in the relative rate of accumulation of short and long range internal stresses. In the case of LiF at room temperature, fatigue hardening is essentially due to the increase in short range stresses. LiF crystals which are susceptible to cleavage fracture, can withstand large tensile stresses in fatigue when compared to monotonic deformation. Activation volume analysis indicates that vacancy and jog concentrations determine the dislocation mobility and fatigue hardening of LiF single crystals. Microscopic examination reveals the existence of very fine slip bands. In the case of crystals subjected to large number of fatigue cycles, surface irregularities and dislocation banding is observed. Optical and electron microscopy suggests dynamic recovery in the crystal studied.

5048 **Numerical studies of fast electron transport in laser irradiated targets.** Bond, D.J. London, England; London University (1980). 171p. British Library, Boston Spa, Wetherby, West Yorks. No. D36881/81.

Thesis (Ph.D.).

An investigation of fast electron transport in solid targets using, primarily, numerical simulation is described with especial reference to the role of the electric field, which drives the thermal return current. Both Monte-Carlo and Multi Group methods have been employed. In the latter total energy has been used as a dependant parameter. Simulation results which show a large inhibition of fast electron transport in targets containing a low density gold layer are presented and a comparison is made with experimental results. The calculation of the electric field in quasi-neutral particle simulation is discussed and a number of methods are compared.

40 CHEMISTRY

4001 Analytical And Separations Chemistry

REFER ALSO TO CITATION(S) 4296, 4300, 4301, 4305, 4311, 4312, 4320, 4321, 4322, 4417, 4418, 4482, 4486, 4488, 4908, 5065, 5067, 5355

5049 **(ACIESP—36-1, pp 277-293) Advice concerning the quantity of buffer solution used in lanthanide complexometric analysis.** Osorio, V.K.L.; Feitosa, M. de L. (Sao Paulo Univ. (Brazil). Inst. de Quimica). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

The influence of buffer quantity used in the titration of complexometric analysis of lanthanides is presented. This allows to determine the optimum quantity of buffer which shows reproducible results. La $(NO_3)_3$.4 dmSO samples are used in the analysis.

5050 **(ACIESP—36-1, pp 200-224) Separation of cerium and fractionation of rare earths from mixed chlorides.** Silva Queiroz, C.A. da; Sood, S.P.; Abrao, A. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

The separation of cerium from rare earths chlorides solutions by precipitation with hydrogen peroxide/air/dil. ammonium hydroxide; purification of cerium; fractionation by ion exchange and analytical control of the process are presented.

5051 **(ACIESP—36-1, pp 225-244) Separation of rare earths by ion exchange method: ion retainer Zn (II) and Cu (II) and Dowex-50 X-4 and Amberlite IR-120 resins.** Pavanin, L.A. (UNESP, Araraquara (Brazil). Inst. de Quimica); Tfouni, E.; Serra, O.A. (Sao Paulo Univ., Ribeirao Preto (Brazil). Faculdade de Filosofia, Ciencias e Letras). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

The separation of rare earths from Brazilian monazite by ion exchange method is presented. The performance of Dowex-50 X-4 (50 to 100 mesh) and Amberlite IR-120 (20-30 mesh) and Cu (II) and Zn (II) is compared.

5052 **(BNL—33895) Gas phase spectroscopy near the carbon K-edge.** Eberhardt, W.; Sham, T.K. (Brookhaven National Lab., Upton, NY (USA); Exxon Research and Engineering Co., Linden, NJ (USA). Corporate Research Science Lab.). 1983. Contract AC02-76CH00016. 8p. (CONF-8310172—3). NTIS, PC A02/MF A01. Order Number DE84002876.

From Advances in soft x-ray science and technology conference; Upton, NY, USA (17 Oct 1983).

Portions are illegible in microfiche products.

Soft x-ray excitation involving C 1s electrons in CO, as well as aliphatic, and aromatic hydrocarbons is found to result in ionic fragmentation of the original molecule. The fragmentation pattern changes whether the C 1s electron gets ionized or excited into a Rydberg-like orbital, or into an unfilled molecular orbital. In this study we correlate the near edge C 1s absorption spectra with the observation of specific ionic fragments of the original molecules.

5053 **(CSIR-RR—588) Standardization of ^{109}Cd revisited.** Meyer, B.R.; Steyn, J.; Conard, F.M.P. (Council for Scientific and Industrial Research, Faure (South Africa). National Accelerator Centre). 1983. 26p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703860.

Revision of two methods for the standardization of the nuclide cadmium - 109, based on the liquid scintillation counting of internal conversion electrons, are described. Two ampoules of a standardized ^{109}Cd solution were sent to the BIPM for comparative measurement in the SIR. The SIR registration table for this important cyclotron-produced nuclide is presented.

5054 **(DOE/ER/10377—5) Fourier transform photoacoustic spectroscopy. Progress report, April 1, 1979-October 31, 1983.** Eyring, E.M. (Utah Univ., Salt Lake City (USA). Dept. of Chemistry). Nov 1983. Contract AC02-79ER10377. 19p. NTIS, PC A02/MF A01. Order Number DE84002175.

Photoacoustic spectroscopy is briefly described and the program is reviewed. Specific recent achievements that are described include an infrared spectral study of quinoline adsorbed on a hydrodenitrogenation catalyst, a combined infrared photoacoustic-crossed polarization magic angle spinning solid state NMR investigation of several oxide bound organometallic complexes, an infrared clarification of the dependence of polyparaphenylene conjugation length on the polymer preparative method, an infrared study of the doping of this organic semiconductor with coordination compounds, and a visible photothermal beam deflection spectral investigation of titanium metal corroded by a hot lubricant.

5055 **(ECN—131) Determination of arsenic, selenium and antimony by neutron activation analysis. Application to hair samples.** Das, H.A.; Hoede, D.; Nieuwendijk, B.J.T.; Sloot, H.A. van der; Teunissen, G.J.A.; Woittiez, J.R.W. (Stichting Energieonderzoek Centrum Nederland, Petten). Apr 1983. 36p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703861.

A fast rabbit system for instrumental activation analysis with reactor neutrons is described. Its use in the determination of selenium in hair is discussed. A survey is given of the correction factors which are inherent to the use of short-lived radionuclides. An alternative to INAA is NAA based on the separation of arsenic, selenium and antimony by hydride evaporation and adsorption to active carbon. Data for some Standard Reference Materials are given. This work was done under research contract 2440/RI/RB with the IAEA.

5056 **(EGG-M—15283) Determination of radium-226 by high-resolution alpha spectrometry.** Sill, C.W. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 56p. (CONF-8310157—2). NTIS, PC A04/MF A01. Order Number DE84002894.

From 29. annual conference on bioassay, analytical and environmental chemistry; Seattle, WA, USA (12 Oct 1983).

Condition were determined under which high resolution and accurate and reliable results can be obtained. Refractory solids are dissolved completely by fusion with KF and Ba-133 tracer. The fluoride cake is then transposed with sulfuric acid to a pyrosulfate fusion. Radium is precipitated with barium by addition of lead perchlorate to a dilute HCl solution of the pyrosulfate cake. The resulting insoluble sulfates are dissolved in an alkaline solution of DTPA and the Ra and Ba sulfates are reprecipitated with acetic acid to produce very small crystals. The precipitate is mounted on 0.1-μm membrane filter and analyzed by alpha spectrometry. Water samples are partially evaporated and treated similarly. Resolution, almost as good as with actinides electrodeposited on polished steel plates, is about 60 keV full-width-half-maximum with 100 μg of barium on a 1-inch filter with a 450 mm^2 detector at 20% counting efficiency. Recovery is about 97%. One solid sample can be prepared for counting in less than 2 hours. Methods are discussed for ensuring reliability of the results. Severe contamination of the surface-barrier detector by polonium-210 and recoil products is discussed.

5057 **(INIS-BR—13) Use of activation analysis in determination of metal trace amounts in water.** Nasrala, A. de P. (Minas Gerais Univ., Belo Horizonte (Brazil). Curso de Posgraduacao em Ciencias e Tecnicas Nucleares). 1982. 160p. (In Portuguese). NTIS (US Sales Only), PC A08/MF A01. Order Number DE83703261.

Thesis (Ph.D.).

The viability of the association of the methods of concentration in resins - developed by the 'Fundacao Centro Tecnologico de Minas Gerais' - CETEC - with neutron activation is studied. Besides the study of the resin behaviour under neutron irradiation,

studies on the variation of the retention rate in function of pH and of the duration of contact of the solution with the resin are carried on. The element to which greater emphasis is given is mercury, whose analysis presents generally serious difficulties. To support the analyses, two automatic methods for gamma spectra analysis, now in operation, were studied and established. In the experimental conditions employed, the detection limits were: 0.5 ppb for cobalt and 1 ppb for mercury.

5058 **(INIS-BR—16) Determination of metallic elements in water by the combined preconcentration techniques of ion exchange and atomic absorption spectrophotometry.** Paula, M.H. de. (Minas Gerais Univ., Belo Horizonte (Brazil). Dept. de Engenharia Nuclear). 1981. 142p. (In Portuguese). NTIS (US Sales Only), PC A07/MF A01. Order Number DE83703262.

Thesis (Ph.D.).

Having as an aim the utilization of atomic absorption method with flame's excitement, the limits of detection in water of six metals (Ag, Co, Cr, Cu, Ni, Zn) were determined in synthetic samples through atomic absorption spectroscopy. Techniques to optimize the data have been pointed out and their statistical treatment presented. By means of the routine and the addition methods three 'real' samples have also been analyzed in order to determine the contents of Cu and Zn. Aiming a pre-concentration and by utilizing the ^{60}Co obtained activating a sample of cobalt in the CDTN/NUCLEBRAS TRIGA MARK-I reactor, the retainement of this cobalt in ion exchange resin and the variation of the factor of elution within different concentration of HCl in water have been determined. The limits of detection are presented and so are the quantitative ones, with and without pre-concentration in an ion exchanger resin followed by elution.

5059 **(INIS-BR—17) Determination of V, W and Mn in fast steels by neutron activation analysis of ^{241}Am/Be source.** Villar, H.P.; Galdino, S.M.L.; Godoy, M.O.; Dantas, C.C. (Pernambuco Univ., Recife (Brazil)). 1982. 15p. (In Portuguese). (CONF-8210153—1). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703263.

From 1. meeting of technology and utilization of Brazilian steels; Rio de Janeiro, Brazil (13 Oct 1982).

Alloying elements are responsible for certain characteristics of the steels which enable their utilization for specific purposes. The concentrations of these elements must comply with strict standards, and the determination of these concentrations involve chemical analyses which are as a rule tedious and expensive. A fast and precise analytical process based on the neutron activation analysis is proposed. A significant correlation ($r = 0.998$) between manganese concentration and mean specific count rate of ^{56}Mn was obtained for activated tool steel samples. Later on, bases for tungsten, vanadium determinations were set.

5060 **(IPEN-Pub—53) Spectrographic determination of microconstituents in uranium tetrafluoride.** Paula Reino, L.C. de; Lordello, A.R. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Nov 1982. 16p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703862.

A espectrographic method for the direct determination of impurities in uranium tetrafluoride (UF_4) was developed. The major impurities introduced during the preparation of UF_4 (Fe, Ni, Cr) and other impurities introduced in the prior stages of this preparation were determined. Spectrochemical carriers were used to suppress the uranium distillation during excitation, because fluoride compound is more volatile the refractory matrix (U_3O_8). Better results were obtained using as carrier a mixture of 20% MgO and 10% MgO and 10% NaCl, concerning to the UF_4 matrix. The sensibilities for some of those impurities are in the ppm level.

5061 **Spectrographic determination of minor constituents in stainless steel.** Sabato, S.F. Sao Paulo, Brazil; Instituto de Pesquisas energeticas e Nucleares (1982). 70p. (In Portuguese). IPEN, Sao Paulo, Brazil.

Thesis (Ph.D.).

Two spectrographic solution techniques, 'Porous Cup' and 'Vacuum Cup', were investigated in order to determine the minor constituents (Cr, Ni, Mo, Mn, Cu and V) of stainless steels. Iron and cobalt were used as internal standards. The precision varied from 4 to 11% for both the spectrographic techniques, where cobalt was used as internal standard. Certified standards from National Bureau of Standards and Instituto de Pesquisas Tecnologicas were analyzed to verify the accuracy of both the techniques. The best accuracy was obtained with the Vacuum Cup technique.

5062 **Spectrographic determination of dysprosium dopant in calcium sulphate used as dosimetric material.** Grigoletto, T. Sao Paulo, Brazil; Instituto de Pasquisas Energeticas e Nucleares (1982). 85p. (In Portuguese). IPEN, Sao Paulo, Brazil.

Thesis (Ph.D.).

A spectrographic method is described for the quantitative determination of dysprosium in doped crystals of calcium sulphate. The consequences of the changes in some parameters of the excitation conditions, such as arc current, electrode type and total or partial burning of sample, in the analytical results are discussed. Matrix effects are investigated by comparison among analytical curves obtained from three different methods of standard preparations. Variations in the intensity of the spectral lines are verificated by recording the spectrum in distinct photographic plates (SA-1). The role of internal standard in analytical reproducibility and in counterbalance of the variations in the arc current and in the weight of sample are studied. The great similarity in excitation behavior of many of the rare earths is used to provide a high degree of internal standardization. Precision studies show a standard deviation of about + - 2,4 percent by use of lanthanum as an internal standard. Accuracy is estimated by comparative analysis of two calcium sulphate samples by X-ray fluorescence, neutron activation and inductive coupled plasma (ICP) emission spectroscopy.

5063 **Equilibrium data in $Th(NO_3)_4$ - $UO_2(NO_3)_2$ - TBP/varsol - HNO_3-H_2O system. Parameters optimization for the ^{232}Th - ^{233}U separation.** Camilo, R.L. Sao Paulo, Brazil; Instituto de Pesquisas Energeticas e Nucleares (1982). 90p. (In Portuguese). IPEN, Sao Paulo, Brazil.

Thesis (Ph.D.).

The extraction behavior of thorium and uranium in TBP diluent systems was studied. The main purpose of this paper is to achieve the best separation conditions of macroquantities of uranium from thorium nitrate solution. The experimental work was started with the determination of the equilibrium diagram for uranium and for thorium. The temperature effect, TBP concentration and organic/aqueous ratio were checked. Experiments with fluoride and aluminum ions in the feed solution were also carried out. From the obtained data and the existing distribution data it was possible to elaborate the correspondent flow sheets for the uranium and thorium recovery from simulated spent thorium fuel solutions.

4002 Inorganic And Physical Chemistry

REFER ALSO TO CITATION(S) 4526

5064 **(ACIESP—25) Development of some phosphors of high quantic efficiency and their application in radiological image reinforcing screens.** Caticha-Ellis, S.; Alvarez, A.G.; Torrianni, I.L.; Lluesma, E.G. (Academia de Ciencias do Estado de Sao Paulo (Brazil)). 1981. 54p. (In Portuguese). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703863.

The establishment of a methodology for the preparation of phosphors and the study of different physical factors which interfere in the process is presented. Emphasis is given on the use of a method of preparation of modern phosphors based on crystalline substracts doped with rare earths.

5065 **(ACIESP—36-1) Proceedings of the 6. Annual Symposium of the ACIESP. Chemistry of rare earths.** Vicentini, G.; Zinner, L.B. (Academia de Ciencias do Estado de Sao Paulo (Brazil)). 1982. 324p. (In Portuguese). (CONF-8111179—). NTIS (US Sales Only), PC A14/MF A01. Order Number DE83703859.

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

Lectures on some spectroscopic aspects, research, production and application of rare earths are presented, as well as papers on the chemistry of rare earths in general, and in particular, of some of those elements.

5066 (ACIESP—36-1, pp 1-71) **Some spectroscopic aspects of the lanthanides.** Sinha, S.P. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). 1982. NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

A review on the spectroscopy of lanthanides is presented.

5067 (ACIESP—36-1, pp 110-146) **Production and applications of rare earths. A field not much explored in Brazil.** Zinner, L.B. (Sao Paulo Univ. (Brazil). Inst. de Quimica). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

A review of general processes of preparation of rare earths as well as their main industrial utilization are presented.

5068 (ACIESP—36-1, pp 151-171) **Addition compounds of lanthanide-and yttrium trifluoromethanesulfonates and N,N-dimethylacetamide (DMA).** Vicentini, G.; Tamura, T. (Sao Paulo Univ. (Brazil). Inst. de Quimica). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

Preparation of addition compounds of hydrated lanthanide trifluoromethanesulfonates and DMA, with general formula Ln $(CF_3\ SO_3)_3.6H_2O.x$ DMA is described. The compounds obtained are characterized by elemental analysis, X-ray diagrams, infrared absorption spectra, electrolytical conductance in nitromethane and acetonitrile, absorption spectra of the neodymium compound and emission spectra of the europium compound.

5069 (ACIESP—36-1, pp 172-184) **Diphenylethylphosphinoxide as ligand with lanthanide salts.** Stucchi, E.B. (UNESP, Araraquara (Brazil). Inst. de Quimica); Souza, M. de (Fundacao de Amparo e Pesquisa, Sao Paulo (Brazil)); Massabni, A.M.G. 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

Chemical preparation of some coordination compounds of diphenylphosphinoxide as ligand and lanthanide-perchlorates and chloride is described.

5070 (ACIESP—36-1, pp 185-199) **Complexes of lanthanide trifluoroacetates, yttrium trifluoroacetates and thioxane oxide (TSO).** Zinner, L.B. (Sao Paulo Univ. (Brazil). Inst. de Quimica). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

Chemical preparation and the characterization of the compounds obtained by the reaction of lanthanide trifluoracetates and thioxane oxide are described.

5071 (ACIESP—36-1, pp 245-263) **Use of lanthanide catalysts in air electrodes.** Souza Parente, L.T. de (Pontificia Univ. Catolica do Rio de Janeiro (Brazil)). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

A review on the lanthanide catalysts suitable for the reduction catalysis of oxygen in air electrodes is presented. The kinds of lanthanide indicated to be used as catalysts of oxygen reduction are shown.

5072 (ACIESP—36-1, pp 264-276) **Electron transfer mechanisms in europium (III) complexes.** Toma, H.E.; Lellis, F.T.P. (Sao Paulo Univ. (Brazil). Inst. de Quimica). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

The electron transfer kinetics of Eu (III) ion and V $(pyc)^{-}_3$ is described.

5073 (ACIESP—36-1, pp 72-109) **Research and applications of rare earths at Instituto de Pesquisas Energeticas e Nucleares (IPEN) - SP, Brazil.** Abrao, A. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1982. (In Portuguese). NTIS (US Sales Only), PC A14/MF A01. (CONF-8111179—).

From 6. annual symposium of the ACIESP; Sao Paulo, Brazil (9 Nov 1981).

A review of studies on rare earths and its applications at IPEN such as rare earth cross section measurements for neutrons, separation processes for rare earths etc are presented.

5074 (INIS-mf—8426) **Chlorine isotope enrichment on a strong alkaline anion exchanger in dependence of type and concentration of the strange electrolytic solution.** Baier, K. (Regensburg Univ. (Germany, F.R.). Naturwissenschaftliche Fakultaet 4 - Chemie und Pharmazie). 1978. 110p. (In German). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83703264.

Thesis (Ph.D.).

Chlorine isotope enrichment for heterogenous ion exchange equilibria was studied. The dependence of element separation effects on the anion of the strange electrolyte (for same cation), on the cation of the strange electrolyte (for same anion), on the concentration of the strange electrolyte and also on the acetone: water ratio of the solvent was investigated.

5075 (MLM—3118(OP)) **Dynamic thermography of thermite chemical heat sources.** Kelly, M.D.; Mohler, J.H.; Dosser, L.R. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1983. Contract AC04-76DP00053. 7p. (CONF-8310218—1). NTIS, PC A02/MF A01. Order Number DE84002837.

From 11. Society of Optical Engineers conference on thermosense; Chicago, IL, USA (2 Oct 1983).

Portions are illegible in microfiche products.

Thermites are solid chemical heat sources that react exothermically by the following equation: $Metal_1$ + $Metal_2$ Oxide → $Metal_1$ Oxide + $Metal_2$ + Heat. This thermite reaction produces a high calorific output that can be used when a concentrated heat source is required. Dynamic evaluation of the thermal profiles generated during thermite reactions requires infrared thermography. The results of this analysis and the technique involved are discussed.

5076 (NYO—6000) **Solubility of fine particles of strontium sulfate.** Enustun, B.V.; Turkevich, J. (Princeton Univ., NJ (USA)). 1 Oct 1959. Contract AA02-78CH00033. 26p. NTIS, PC A03/MF A01. Order Number DE84003472.

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The Ostwald-Freundlich equation for the solubility of fine particles was extended to crystals of any geometry with any number of different interfacial tensions. Measuring the particle sizes by electron microscopy, the solubility of $SrSO_4$ particles in the colloidal range was investigated by a tracer method at 25.0°C. Results are in good agreement with the theory. The smallest particles in a given population appear to control the solubility. The solid $SrSO_4$/solution mean interfacial tension was calculated as 84 +- 8 erg. $cm.^{-2}$ at 25.0°C against a much higher value given in the literature, which is considered to be in error. From precipitation experiments the size of $SrSO_4$ nuclei is estimated to be ca. 18A°.

5077 **(RISO-M—2366) Kinetics of the reaction of hydroxyl radicals with ethane and a series of Cl- and F-substituted methanes at 300-400degK. OH as a tropospheric sink preventing ozone depletion.** Bjarnov, E.; Munk, J.; Nielsen, O.J.; Pagsberg, P.; Sillesen, A. (Risoe National Lab., Roskilde (Denmark)). Apr 1982. 133p. NTIS (US Sales Only), PC A07/MF A01. Order Number DE83703864.

Gas phase reactions of hydroxyl radicals with ethane and a series of Cl- and F-substituted methanes were studied at atmospheric pressure and over the temperature range 300-400degK. Hydroxyl radicals were produced by pulse radiolysis of water vapour and the decay rate was studied by monitoring the transient light absorption at 3090 A. Arrhenius parameters (A,Esub(a)) for the reaction RH + OH arrow R + HOH were obtained for the reactants RH = C_2H_6,CH_3Cl,CH_2Cl_2,$CHFCl_2$. CF_2Cl_2 (CFC-12) which contains no C-H bonds was found to be inert toward attack by hydroxyl radicals. Since no other tropospheric sink reactions have been reported for CFC-12 its possible impact on the stratospheric ozone remains a controversial problem.

5078 **(SAND—83-1388C) Photoenhancement of gas-solid reactions by surface excitation.** Ashby, C.I.H. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 12p. (CONF-831174—12). NTIS, PC A02/MF A01. Order Number DE84003106.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Ultraviolet irradiation of the surface of graphite leads to the enhancement of the reaction of graphite with hydrogen to form methane under conditions were photo-induced thermal effects are negligible. Wavelength dependence of the photoenhancement correlates with excitation of the - valence to -conduction transition of graphite centered at 260 nm. Subsequent formation of some reactive excited state species leads to enchanced reaction rates. Likely candidates for such reactive species have been identified by comparative kinetic studies of the thermal and the photoenhanced reactions. For example, at low temperature (< 500 K), the rate limiting step of the thermal reaction is addition of H to surface CH_3 groups, and the observed photoenhancement can be explained by activation of these CH_3 groups.

4003 Organic Chemistry

REFER ALSO TO CITATION(S) 4287, 4978, 5066, 5068, 5069, 5070, 5072, 5077

5079 **(DOE/EV/02958—7) Development of newer methods for the isolation and identification of certain components found in complex mixtures derived from energy sources and the determination of their biological activity via bioassay systems. Final summary, December 1, 1980-November 30, 1983.** Lipsky, S.R. (Yale Univ., New Haven, CT (USA). School of Medicine). Nov 1983. Contract AC02-76EV02958. 26p. NTIS, PC A03/MF A01. Order Number DE84003180.

Multidimensional capillary column gas chromatography proved to be capable of readily separating more individual components of complex mixtures than any other system. By utilizing the technique of Sample Trapping and/or Sample Transfer, a single component or a series of components can be held in obeyence and at will, be quantitatively transferred to either/or (1) another column (2) another detector (3) a mass spectrometer (or any other appropriate identification device) and (4) finally and most importantly, to a suitable bioassay system. With Sample Trapping, the segment of sample of interest is first trapped out in a small volume loop of inert tubing at liquid CO_2 temperatures and at an appropriate time it is rapidly heated. The volatilized is directed to the inlet of column No. 2. Under these circumstances, oft times band broadening is minimized and superior resolution of all of the component bands is achieved on the second column. For Sample Enrichment, repeated injections of the same are automatically cut for components of interest until sufficient sample is present in the trap for analysis via High Resolution Mass Spectrometry or NMR.

5080 **(PNL-SA—11552, pp 251-262) Chemical and biological characterization of phenanthrene hydroaromatics.** Wozniak, T.J.; Hites, R.A. (School of Public and Environmental Affairs, Bloomington, IN). 1983. NTIS, PC A18/MF A01. (CONF-811160—).

From US Department of Energy workshop on chemical characterization of hazardous substances in synfuels; Seattle, WA, USA (2 Nov 1981).

Partially hydrogenated polycyclic aromatic hydrocarbons (hydroaromatics) are an abundant class of compounds in synthetic fuels produced from coal (1 to 4). They result both from the initial production process and from the additional hydrogenation used to reduce the mutagenicity of the original material (5 to 7). Unfortunately, the ability to identify and quantify hydroaromatics is poor, and knowledge of their toxicological properties is limited. Thus, the overall goals of this project are to develop the analytical chemistry methods and data base which will facilitate the measurement of hydroaromatics, to apply these methods to a few coal liquid samples, and to determine the mutagenicity and acute toxicity of the individual hydroaromatics. To develop the analytical methods, we have begun with mixtures of compounds produced by the hydrogenation of a few simple model compounds. The analysis of the hydroaromatics produced by the high pressure, high temperature hydrogenation of phenanthrene and fractionated before mass spectroscopy is described.

5081 **Study of the chemistry of some heterocycles of potential interest as radiosensitizers.** Moazzam, M. Uxbridge, England; Brunel University (1981). 284p. British Library, Boston Spa, Wetherby, West Yorks. No. D37034/81.

Thesis (Ph.D.).

A brief survey of types of chemicals used as radiosensitizers for hypoxic cells is given together with an account of the quantitative structure-activity relationships in design of radiosensitizers, and a review of some aspects of imidazole chemistry. Attempts to prepare compounds of value as radiosensitizers are described. These compounds are either of the conventional type in that they contain nitro substituents as an aromatic nucleus or unconventional in that they have more than one electron-withdrawing substituent, each substituent taken separately being a less powerful electron-withdrawing group than the nitro group. Nitroimidazoles are important radiosensitizers but neuro-toxicity accompanies their use. The preparations of imidazoles having acid, ester, amide, cyano, aldehyde and ketone, carboxylic acid hydrazide and trifluoromethyl groups are described. It is interesting that the two of these compounds that were assessed showed high electron-affinity but very poor radiosensitizing properties. Some bicyclic systems carrying electron-withdrawing substituents were prepared. Sometimes the nitro substituent was included and the imidazole moiety featured in some of the bicyclic systems.

4004 Electrochemistry

REFER ALSO TO CITATION(S) 4776, 4779

4006 Radiation Chemistry

REFER ALSO TO CITATION(S) 4452, 5077

4007 Radiochemistry And Nuclear Chemistry

REFER ALSO TO CITATION(S) 4463

5082 **(INIS-mf—8182) Hot atom chemistry of sulfur. Bibliography.** Todorovski, D.S.; Koleva, D.P. (Sofia Univ. (Bulgaria). Khimicheski Fakultet). 1982. 47p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703265.

An attempt to cover all papers dealing with the hot atom chemistry of sulfur is made. Publications which: a) only touch the problem, b) contain some data, indirectly connected with sulfur hot atom chemistry, c) deal with ^{35}S-production from a chloride matrix, are included as well. The author's name and literature

source are given in the original language, transcribed, when it is necessary, in Latin. A number of primary and secondary documents have been used including Chemical Abstracts, INIS Atomindex, the bibliographies of A. Siuda and J.-P. Adloff for 1973 - 77, etc.

4008 Combustion, Pyrolysis, And High-temperature Chemistry

5083 **An asymptotic theory of condensed two-phase flame propagation.** Margolis, S.B. (Sandia National Lab., Livermore, CA). *SIAM Journal on Applied Mathematics;* **43**: 289-301(Apr 1983).

A model is presented for flame propagation though a condensed combustible mixture in which the limiting component of the mixture melts during the reaction process. An asymptotic analysis, valid for large activation energies, is employed to derive a two-term expansion for the steady, planar adiabatic flame speed. A linear stability analysis is then used to show that for sufficiently large values of the activation energy and/or a special group of melting parameters, the steady, planar solution loses stability to various types of planar and nonplanar pulsating modes. The effect of melting is found to be destabilizing in the sense that these pulsating modes occur for lower values of the activation energy than would be the case for strictly solid fuel combustion.

42 ENGINEERING

4201 General Engineering

5084 **(ORNL-tr—5055) VDI 2230: systematic calculation of high duty bolted joints.** (Oak Ridge National Lab., TN (USA); Verein Deutscher Ingenieure (VDI), Duesseldorf (Germany, F.R.)). [nd]. Contract W-7405-ENG-26. Translation source information not available . 155p. NTIS, PC A08/MF A01. Order Number DE84003447.

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The guideline VDI 2230 deals with bolted joints which are to bear static or alternating working loads and which are to be created using high-strength bolts. The guideline should be used above all for joints the failure of which can cause serious damage. The specifications in this guideline are valid for steel bolts within the temperature range of -40°C to 300°C in which neither embrittlement due to cold nor creep stress of the bolt steels is expected. Above 120°C the adjusted material characteristics must be used for calculations.

4202 Facilities And Equipment

REFER ALSO TO CITATION(S) 4376, 4377, 4378, 4379, 4390, 4428, 4432, 4433, 4436, 4437, 4468, 4469, 4470, 4471, 4600, 5159, 5169, 5184, 5201, 5208, 5275, 5276, 5315, 5602

5085 **(CONF-820546—18) Maximum allowable resistive zone in a metastable conductor.** Dresner, L. (Japan Atomic Energy Research Inst., Tokai, Ibaraki). 1982. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01. Order Number DE84003300.

From 9. international cryogenic engineering conference; Kobe, Japan (10 May 1982).

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This paper gives explicit formulas for (1) the maximum fault resistance allowable in a metastable conductor and (2) the reduction in MPZ energy caused by any fault. Both formulas are strictly applicable when the thermophysical properties are constant. The paper also gives a generalization of the first formula that covers the case of a three-part boiling (rather than a constant) heat transfer coefficient.

5086 **(CONF-830607—30) Nonlinear bending and collapse analysis of a poked cylinder and other point-loaded cylinders.** Sobel, L.H. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jun 1983. Contract AC15-76CL50003;AC15-76CL02395. 42p. NTIS, PC A03/MF A01. Order Number DE84001853.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

This paper analyzes the geometrically nonlinear bending and collapse behavior of an elastic, simply supported cylindrical shell subjected to an inward-directed point load applied at midlength. The large displacement analysis results for this thin (R/t = 638) poked cylinder were obtained from the STAGSC-1 finite element computer program. STAGSC-1 results are also presented for two other point-loaded shell problems: a pinched cylinder (R/t = 100), and a venetian blind (R/t = 250).

5087 **(DOE/SR/00001—T10) Modifications for seismic upgrading of the exhaust stack and actuator tower of Building 105-L, Savannah River Plant.** (URS/John A. Blume and Associates, Engineers, San Francisco, CA (USA)). 13 Oct 1982. Contract AC09-76SR00001. 11p. NTIS, PC A02/MF A01. Order Number DE84003030.

This report summarizes the work conducted to develop construction drawings for upgrading the exhaust stack and actuator tower of Building 105-L at the Savannah River Plant near Aiken, South Carolina. These structures required modifications to conform to the Housner seismic criteria development in 1967. The similarity of the Building 105-C and Building 105-L exhaust stacks, actuator towers, and their supporting structures was established through a comparison of structural drawings and design information. The modifications developed by URS/Blume to upgrade the Building 105-C exhaust stack and actuator tower to meet the requirements of the 1967 Housner seismic criteria can be used to upgrade the stack and tower of Building 105-L. It is concluded that the exhaust stack and actuator tower of Building 105-L will conform to the requirements of the Housner criteria if the structural modifications shown on the construction drawings are implemented. 4 references.

5088 **(N—8326038) Development of small cryogenic heat pipes, phase 3 report.** Mathieu, J.P. (Societe Anonyme Belge de Constructions Aeronautiques, Brussels). Sep 1982. 149p. NTIS, PC A07/MF A01.

Stainless steel heat pipes of 3 and 6mm diameter featuring a mesh capillary, charged with either ethane, methane, nitrogen or oxygen, 1 m and 0.35 m in length and with 0.8, 0.2 and 0.1 m condenser lengths were submitted to determination of their maximum power versus temperature and versus tilt. Priming behavior, burst pressure, leak detection technique, and resistance to sine and random vibrations were studied. Information concerning these features is used to complete a set of detail specifications for all the heat carriers concerned.

5089 **(PNL-SA—11251) Critical experiments at Pacific Northwest Laboratory.** Clayton, E.D.; Bierman, S.R. (Pacific Northwest Lab., Richland, WA (USA)). Sep 1983. Contract AC06-76RL01830. 53p. (CONF-8309105—1). NTIS, PC A04/MF A01. Order Number DE84001551.

From International seminar on criticality experiments and data; Dijon, France (20 Sep 1983).

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Critical experiment programs at the Critical Mass Laboratory (CML) of the Pacific Northwest Laboratory (PNL) are discussed and projected requirements for critical experiment data in different areas of the fuel recycle; processing, fabrication, storage and shipment are reviewed. Recent experiments at the CML include: Criticality Measurements on (1) homogeneous aqueous solutions of Pu and U (up to 60 wt% Pu), (2) plutonium nitrate solutions with Cd as a soluble absorber, (3) heterogeneous lattice assemblies of low enriched uranium with high reactivity hold down achieved by means of a soluble absorber (boron) in the water moderator, (4) lattice assemblies with LWR type fuel in water containing gadolinium nitrate as soluble absorber, (5) interacting arrays of bottles of Pu solutions and (6) interacting arrays of bundles of low enriched uranium lattice assemblies in water with lead, steel and depleted uranium reflectors. Neutronic measurements are described wherein neutron flux spatial and spectral mapping have been done with solid state track recorders (SSTR) to provide data on fission rates and neutron spectrum.

5090 **(SAND—83-2377C) Manufacturing technology - SNLA.** Walters, J.K. (Sandia National Labs., Albuquerque, NM (USA)). 7 Nov 1983. Contract AC04-76DP00789. 25p. (CONF-8310219—1). NTIS, PC A02/MF A01. Order Number DE84002804.

From EIVR-37 meeting; Livermore, CA, USA (25 Oct 1983).

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Narration and viewgraphs are given for a presentation that overviews Sandia Laboratories with an emphasis on Sandia's involvement in manufacturing technology. The primary mission involves responsibility for nuclear weapon engineering, but other missions of national importance are included. Equipment used in carrying out the manufacturing part of the mission are illustrated. (LEW)

5091 **(SAND—83-7442) Engineering risk analysis of the extreme dynamic accelerations on deck cargo barges at sea.** Hutchison, B.L. (Sandia National Labs., Albuquerque, NM (USA)). Nov 1983. Contract AC04-76DP00789. 136p. (TTC—0447). NTIS, PC A07/MF A01. Order Number DE84003973.

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An engineering study was performed to establish extreme value accelerations on barge decks which could serve as a basis for a tie-down standard for shipment of large Type B packages of radioactive material. Extreme values were estimated for a range of barge sizes and for domestic shipments along coastal waters. Rigorous and simplified tie-down standards are proposed for incorporation into an American National Standards Institute standard.

5092 **(UCRL—89852) Rail accelerator development for ultra-high pressure research.** Hawke, R.S.; Nellis, W.J.; Rego, J.; Susoeff, A.R.; Newman, G.H. (Lawrence Livermore National Lab., CA (USA)). 20 Sep 1983. Contract W-7405-ENG-48. 6p. (CONF-8310212—1). NTIS, PC A02/MF A01. Order Number DE84002452.

From 34. meeting of the Aeroballistic Range Association; Williamsburg, VA, USA (5 Oct 1983).

The Lawrence Livermore National Laboratory is currently developing a rail accelerator system for launching hypervelocity projectiles suitable for ultrahigh pressure shockwave research. The primary goal is to accelerate 1 g projectiles with disk impactors to velocities in excess of 12 km/s and generate uniform, planar shockwaves at pressures above 0.5 TPa (5 Mbar) in metal targets. In order to generate precisely controlled impacts and shockwaves, several strigent requirements are imposed on the railgun system. During the last year, we have begun detailed development of a railgun launcher and power source. We are developing a launcher with a gas injector. The injector accelerates the projectile to more than 1 km/s reducing the dwell time of the plasma arc and the erosion of the rails. The injected projectile, with a fuse, also serves as the main switch in the power supply circuit. Current pulse shaping is used to control the applied stress to the projectile and launcher. Results of experiments with the new system will be reported and compared to computer simulations.

5093 **(UCRL—89870) Interactive computer-aided control systems engineering.** Herget, C.J.; Gavel, D.T.; Tilly, D.M. (Lawrence Livermore National Lab., CA (USA)). 28 Sep 1983. Contract W-7405-ENG-48. 3p. (CONF-8311103—1). NTIS, PC A02/MF A01. Order Number DE84002456.

From 2. annual workshop on interactive computing; Washington, DC, USA (30 Nov 1983).

In this article, we will briefly present an overview of activities in the relatively new field of Computer-Aided Control Systems Engineering. We will discuss the nature of control system design using computers, provide references to present activities, and discuss our current effort in this field.

5094 **Collecting apparatus.** Duncan, C.P. (to US Department of Energy). US Patent 4,399,629. 23 Aug 1983. Filed date 5 Mar 1981. vp.

PAT-APPL-240688.

An improved collecting apparatus is disclosed for small aquatic or airborne organisms such as plankton, larval fish, insects, etc. The improvement constitutes an apertured removal container within which is retained a collecting bag, and which is secured at the apex of a conical collecting net. Collectors are towed behind a vessel or vehicle with the open end of the conical net facing forward for trapping the aquatic or airborne organisms within the collecting bag, while allowing the water or air to pass through the apertures in the container. The container is readily removable from the collecting net whereby the collecting bag can be quickly removed and replaced for further sample collection. The collecting bag is provided with means for preventing the bag from being pulled into the container by the water or air flowing therethrough.

5095 **Spent fuel cask regulatory standards and guidance.** Hopkins, D.R. (U.S. Nuclear Regulatory Commission, Washington, DC 20555). *Transactions of the American Nuclear Society;* **44**: 473-474(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

5096 **Spent fuel shipping cask shielding considerations.** Wells, A.H. (Nuclear Data, Inc., 2734 S. Cobb Industrial Boulevard, Smyrna, GA 30080). *Transactions of the American Nuclear Society;* **44**: 475-476(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

5097 **1.8K test of binary and ternary superconducting conductors.** Wake, M.; Hirabayashi, H.; Inove, K.; Itoh, K.; Kobayashi, M.; Shintomi, T.; Tsuchiya, K.; Wada, H. (KEK Nat'l Lab. for High Energy Physics, Ohomachi Ibaraki, 305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 552-555(May 1983).

A series of short sample tests have been carried out on Nb-Ti-based binary and ternary alloy conductors. It turns out that the current carrying capacities at high fields of both binary and ternary alloys can be remarkably improved over those previously reported by heavy cold-working after heat treatment. It should be emphasized that the superconducting performance of these ternary alloy conductors manufactured in industrial scale are fairly reliable and that the best results are obtained with Nb-Ti-Ta ternary alloys. Results are shown also on long samples and large kiloampere cables.

5098 **Scaleup of powder metallurgy processed Nb-Al multifilamentary wire.** Thieme, C.; Foner, S.; Otubo, J.; Pourrahimi, S.; Schwartz, B.; Zhang, H. (Francis Bitter National Magnet Lab. and Plasma Fusion Center Massachusetts Instit. of Techn., Cambridge, MA 02139). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 567-569(May 1983).

Power metallurgy processed Nb-Al superconducting wires were fabricated from billets up to 45 mm o.d. with nominal areal reduction ratios, R, up to 2 X 10^5, Nb powder sizes from 40 to 300 μm from various sources, Al powder sizes from 9 to 75 μm, Al concentrations from 3 to 25 wt % Al and with a wide range of heat treatments. All the compacts used tap density powder in a Cu tube and swaging and/or rod rolling and subsequent wire drawing. Both single strand and bundled wires were made. Overall critical current densities, J /SUB c/, of 2 X 10^4 A/cm^2 at 14 T and 10^4 A/cm^2 at 16 T were achieved for 6 to 8 wt % Al in Nb.

5099 **Safety and stability of superconducting magnets for fusion using cooled conductors.** Turner, L.; Ryne, R. (Argonne Nat'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 685-687(May 1983). Contract AC07-76ID01570.

Vincent Arp's computer code for the stability analysis of internally cooled conductors (ICC) has been combined with ANL's TASS code to create the code SSICC for the analysis of the safety and stability of ICC. The code has been tested against the ICC experiments of Lue, Miller, and Dresner, and applied to the FED TF coil conductor.

5100 **The source, origin and propagation of quenches measured in superconducting dipole magnets.** Caspi, S.; Hassenzahl, W. (Lawrence Berkeley Lab., University of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 692-695(May 1983). Contract AC03-76SF00098.

Transitions from the superconducting to normal state at 4.4 and 1.8 K in several model accelerator dipoles were recorded by a fast data acquisition system. The resistive voltage rise in the conductor during the transitions is used to determine accurately the location of the quench source in the magnets and to estimate the axial and turn-to-turn quench velocities. The quench velocity, temperature evolution and energy deposition in the coil were calculated using the program QUENCH, and are in reasonable agreement with the data. In the two dipole magnets studied, the transitions almost always occurred in the regions of highest field. In one coil the high field region is in the straight section because the field in this region is enhanced by iron support rings. In the other magnet the high field region is at the end, in the innermost turn of the first layer. Some quenches were preceded by large voltage spikes that can be ascribed to conductor motion. Other quenches do not appear to be associated with any large energy release. Acoustic emission (AE) was monitored during the tests and AE bursts were observed simultaneous with the initial voltage spike. An increased AE signal continued as the quench progressed.

5101 **Doubler system quench detection threshold.** Kuepke, K.; Kuchnir, M.; Martin, P. (Fermi Nat'l Accelerator Lab., P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 696-699(May 1983).

The experimental study leading to the determination of the sensitivity needed for protecting the Fermilab Doubler from damage during quenches is presented. The quench voltage thresholds involved were obtained from measurements made on Doubler cable of resistance x temperature and voltage x time during quenches under several currents and from data collected during operation of the Doubler Quench Protection System as implemented in the B-12 string of 20 magnets. At 4kA, a quench voltage threshold in excess of 5.0V will limit the peak Doubler cable temperature to 452K for quenches originating in the magnet coils whereas a threshold of 0.5V is required for quenches originating outside of coils.

5102 **Development and testing of a 50 KA, pulsed superconducting cable.** Wollan; DeClerc, J.; Hamilton, W.; Zeitlin, B. (Los Alamos Nat'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 715-719(May 1983).

Prototype cables for 7.5 T, pulsed field application in tokamak poloidal field coils have been designed, fabricated, and evaluated. Successful fabrication of a 10 m superconducting sample represents the largest superconducting cable ever made. Details of the fabrication, the problems expected and encountered, and the solutions to those problems are discussed. Results of stability measurements on the superconducting prototype also are presented.

5103 **Critical current measurements on superconducting cables.** Garber, M.; Sampson, W.; Tannenbaum, M. (Brookhaven Nat'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 720-723(May 1983).

This paper describes the essential features of short sample measurements on high current superconducting cables. The purpose of such measurements is threefold: to provide a basis of comparison for assessing magnet performance, to provide Quality Assurance data on purchased materials, and to evaluate metallurgical R & D aimed at understanding and improving conductor performance. Additional properties of the cabled conductors, such as quench propagation velocity, heat pulse stability, and resistivity are readily studied with the apparatus described. The method of measurement is very similar to that employed previously for braided conductors. It has been improved in several respects with a view to achieving results which are reliable to 1 or 2%.

5104 **Structural behavior of cable superconductors.** Becker, H.; Marston, P. (Massachusetts Instit. of Technology, Plasma Fusion Center, Cambridge, MA 02139). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 724-727(May 1983).

The structural properties of cable superconductor coils, for particle accelerators such as the Tevatron and the CBA (Colliding Beam Accelerator), depend upon direction of loading. For compression perpendicular to the "flat faces" of the conductor, the coils exhibit nonlinear, inelastic and time dependent behavior. The same is true for "inplane" compression loading perpendicular to the conductor edges. In the lengthwise direction, the coils display tension and compression stress-strain curves typical of structural metals. The loading of primary concern is compression perpendicular to the conductor faces since deformations in that direction can have a major influence on magnetic field quality. However, the coil behavior under that condition is uncertain because of the nonlinear stress strain curve complicated by creep and relaxation at the stress levels induced by preloading and Lorentz forces. Furthermore, the stiffness of the loading fixture appears to influence the data as shown by results from tests run under different conditions at Berkeley, Brookhaven and MIT. The paper displays test data on stress-strain curves for all three loading directions. Results are presented for RT, 77 K and 4 K behavior. Data of various investigators are compared. The applicability of a relatively simple power law between stress and strain is depicted.

5105 **Mechanical properties of Nb_3Sn stranded superconducting potted cable windings.** Caspi, S.; Meuser, R.; Wolgast, R. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 728-732(May 1983). Contract AC03-76SF00098.

The electromagnetic stresses in projected designs of high-field magnet coils sometimes exceed the yield points or creep strengths of the presently used coil winding materials. This is especially true of reactafter-winding Nb_3Sn coils, plastic insulating materials, and the crossed strands of twisted cable. This report presents compression stress-strain curves of stranded and twisted flat cable coil winding specimens for reacted and epoxy-impregnated Nb_3Sn coils, at 300 K and 80 K. The lateral and longitudinal strains of one specimen were measured along with the direct compressive stress-strain, at 300 K. A similar specimen was compressed to 40 MPa (6 kpsi) at room temperature and then to 145 MPa (20 kpsi) at 80 K. Plastic flow occurred up the maximum stress. Stress cycles subsequent to maximum stress were elastic. Some specimens were mounted in a rigid enclosure to simulate hydrostatic containment of the magnet coil. Pure annealed Cu was tested at 300 K, and pure epoxy was tested at 300 and 80 K. In addition the thermal contractions from 300 to 80 K were measured.

5106 **Tin core processing of powder metallurgy Cu-Nb-Sn.** Zhang, H.; Foner, S.; Otubo, J.; Pourrahimi, S.; Schwartz; Thieme, C. (Francis Bitter Nat'l Magnet Lab. and Plasma Fusion Center, Massachusetts Instit. of Techn., Cambridge, MA 02139). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 769-772(May 1983).

Powder metallurgy processed Cu-Nb-Sn superconducting wires were fabricated using different internal tin core geometries. Variations of the process included: a single central tin core surrounded by a multifilamentary composite or by a multistrand powder composite, and bundled multistrand compacts, each containing a tin core. External Ta or Nb barriers were also incorporated in the wire. Nominal areal reductions of 10^4 to 10^6 were used. Overall critical current densities of 3×10^4 A/cm^2 at 14 tesla were achieved.

5107 **Design of radioactive material shipping packaging for low-velocity puncture resistance.** Nickell, R.E. (Electric Power Research Inst., Palo Alto, CA (USA)); May, R.A. (Sandia National Labs., Albuquerque, NM (USA)). *Nuclear Engineering and Design;* **74**: No. 2, 223-232(Feb 1983).

Both the standards developed by the International Atomic Energy Agency (IAEA) and those contained in the U.S. federal

regulations stipulate that transport packagings containing large quantities of radioactive material, such as spent fuel from a nuclear power reactor or waste by-products from nuclear weapons programs, should be designed to resist a sequence of impact, puncture, fire, and water immersion conditions without harmful release of contents. A recent paper has offered a perspective on the design of such packagings relative to the impact event - a 30 ft (9m) drop onto an essentially unyielding target. In this paper the second event in the accident design sequence is addressed - the 40 in (1 m) drop of the packaging, after primary impact, onto a mild steel cylindrical punch.

5108 **Seismic response of large suspended tanks.** Ma, D.C.; Chang, Y.W.; Gvildys, J. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, [Paper]:* No. 83-PVP-70, 6(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

The response of a large-diameter liquid-filled tank to seismic disturbances is studied in this paper with the emphasis on the effects of the bottom plate vibration on fluid dynamic pressure and free-surface sloshing. The fluid in the tank is treated as a continuum medium, which is quite different from the conventional method that treats the fluid as an added mass attached on the tank wall. As a result, important effects such as free-surface sloshing, fluid-structure interaction, and flexibility of the tank are included in the analysis.

5109 **Using Markov Chain models to describe crack growth and inspection effectiveness.** Heasler, P.G.; Simonen, F.A. (Pacific Northwest Laboratory, Richland, WA). *American Society of Mechanical Engineers, [Paper]:* No. 83-PVP-88, 8(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

This paper describes the use of a simple Markov Chain model for probabilistic fracture mechanics calculations. The model describes the effects of nondestructive inspection as well as crack growth and allows inspection scenarios to be evaluated efficiently. Failure probabilities can be calculated analytically from the model, and Monte Carlo simulation is not required. Markov Chain model results are compared to that of a more complicated Monte Carlo computer code. Finally, the Markov Chain is used to examine crack growth in a feedwater line. These feedwater line results illustrate the interrelationships between inspection effectiveness, material quality and crack growth.

5110 **Programmable calculator stress analysis.** Van Gulick, L.A. (Los Alamos National Laboratory, Los Alamos, NM). *American Society of Mechanical Engineers, [Paper]:* No. 83-PVP-29, 6(1983). (CONF-830607—).

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

This paper assesses the suitability of advanced programmable alphanumeric calculators for closed form calculation of pressure vessel stresses and offers, as their advantages, adequate computing power, portability, special programming features, and simple interactive execution procedures. Representative programs which demonstrate their capacities are presented. Problems dealing with stress and strength calculations in thick-walled pressure vessels and with the computation of stresses near head/pressure vessel junctures are treated. Assessed favorably in this paper as useful contributors to computeraided design of pressure vessels, programmable alphanumeric calculators have areas of implementation in checking finite element results, aiding in the development of an intuitive understanding of stresses and their parameter dependencies, and evaluating rapidly a variety of preliminary designs.

5111 **Nonlinear bending and collapse analyses of a poled cylinder and other point-loaded cylinders.** Sobel, L.H. (Westinghouse, Advanced Reactors Division, Madison, PA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 76**: 1-18(1983). (CONF-830607—). Contract AC15-76CL02395;AC15-76CL50003.

Numerical results based on the STAGSC-1 finite element computer program are presented for the geometrically nonlinear behavior of cylindrical shells subjected to inward-driected radial point loads. Three elastic shell problems are considered: the poked cylinder (single load at midlength), which is the problem of primary interest, and the venetian blind and pinched cylinder, which are check cases. Load versus displacement curves obtained for the three problems reveal that geometric nonlinear (large displacement) effects are important. For the poked cylinder it is concluded that the maximum at the limit point of the load-displacement curve corresponds to a small local snapping of the cylinder that does not result in a loss of load-carrying capacity. The paper also discusses certain features of STAGSC-1 that should be helpful to users of the program.

5112 **An overview of current PVRC design division programs.** Greenstreet, W.L. (Oak Ridge National Laboratory, Oak Ridge, TN). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL.57**: 11-22(1982). (CONF-820601—). Contract W-7405-ENG-26.

Brief descriptions are given of programs now in progress under the Pressure Vessel Research Committee (PVRC) Design Division. Studies that have either been completed recently or are nearing completion are covered along with outlines of new and continuing projects for FY 1981-82. Selected projects are given greater coverage to better illustrate the work being done. A sketch of the origin, purpose, and organization of the PVRC is given for background information.

5113 **Dynamically mooring large structures in deep waters.** Webb, J.T.H. (Wharton Engineers (Elstree) Limited, England). pp 1034-1050 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The development of a mooring system for large structures to take advantage of modern traction systems is shown to be feasible. The design criteria which are required are indicated and the method of sizing equipment and its control is outlined. 3 references.

4203 Lasers

REFER ALSO TO CITATION(S) 5317

5114 **(DOE/ER/12012—2) Energy transfer and nonlinear optical properties at near ultraviolet wavelengths: rare earth 4f->5d transitions in crystals and glasses. Progress report, April 1, 1983-March 31, 1984.** Hamilton, D.S. (Connecticut Univ., Storrs (USA)). Nov 1983. Contract AC02-82ER12012. 53p. NTIS, PC A04/MF A01. Order Number DE84003188.

Current status of work on the nonlinear optical properties of rare earth ion doped crystals is summarized. The transient absorption processes in Ce^{3+}:YAG are discussed. Next reported is the formation of thermally and optically unstable color centers in Ce^{3+}:CaF_2 created by laser irradiation at 308 nm. This wavelength is near the peak of the 4f to lowest 5d absorption of the cerium ions. Work in the nonresonant two-photon absorptions in Ce^{3+}:CaF_2 is updated. The current status of theoretical activity directed toward understanding the overall strength and polarization anisotropy of the two-photon transitions in Ce^{3+}:CaF_2 is also presented. (LEW)

5115 **(LBL—16640) Free electron laser with versatile polarization capability.** Kim, K.J. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 14p. (CONF-8309118—1). NTIS, PC A02/MF A01. Order Number DE84002889.

From Topical meeting on free electron generation of extreme ultraviolet coherent radiation; Upton, NY, USA (19 Sep 1983).

A novel configuration of free electron laser system is proposed that is capable of generating coherent radiation whose polarization is arbitrary and rapidly adjustable. The magnet configura-

tion is similar to that of the optical klystron except that the undulators are placed perpendicular rather than parallel to each other. The gain of the system is analyzed in the small signal regime, and is found to be similar to that of the optical klystron. The polarization of the laser radiation at maximum gain is found to be different from the polarization of the spontaneous radiation.

5116 **(N—8327211) The phase noise of semiconductor lasers in single mode optical fiber heterodyne systems.** Mendieta, F.J. (Ecole Nationale Superieure des Telecommunications, 75 - Paris (France)). Dec 1982. 93p. (FRENCH). NTIS, PC A05/MF A01.

Heterodyne photodetection and the influence of the laser phase noise on the detector output are analyzed. Models describing the incidence of phase noise on the heterodyne output current in the cases of correlated and noncorrelated waves are discussed. The stabilization procedures for semiconductor lasers are examined, and the incidence of temperature, injection, current and pressure on the average wavelength of a GaAlAs laser are detailed. A single mode fiber heterodyne interferometer of a Mach Zender type was used to determine the energy density spectrum. Results show a band width of tens of kHz in the case of a stabilized HeNe Laser, while for a AsAlGa semiconductor laser source a spectral band width of 10 MHz/mW is found.

5117 **The UK free electron laser project.** Poole, M.W.; Firth, W.J.; Gillespie, W.A.; Kelliher, M.G.; Pidgeon, C.R.; Reid, J.M.; Saxon, G.; Smith, S.D.; Walker, R.P. (SERC, Daresbury Lab., Daresbury, Warrington WA4 4AD). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3091-3093(Aug 1983).

Construction of apparatus for a free electron laser experiment is being undertaken by a collaboration involving principally groups at the Heriot-Watt and Glasgow Universities and at the SERC Daresbury Laboratory. The experiments will be centred on 10.6 μm but a tuning range of at least 2-20 μm will be investigated. The gain has been optimised in a regime of large linewidth broadening arising from the electron beam and wiggler magnet properties. The performance of the electron linac source is being improved and a new beam line is under construction. A periodic magnet design utilising samarium cobalt blocks has been chosen and will be assembled and tested shortly. Following electron beam commissioning tests it is planned to start a comprehensive study of FEL characteristics late in 1983.

5118 **Amplifier optimization study for an FEL wiggler with a helical magnetic field and an axial electric field.** Takeda, H.; Segall, S.B. (KMS Fusion, Inc., Ann Arbor, MI 48106). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3112-3114(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A one-dimensional multiparticle free electron laser (FEL) amplifier simulation code based on a single particle interaction model is used to determine laser gain and energy spread in an FEL amplifier in which gain is enhanced by means of an axial electric field. Limitations on achievable laser intensity due to limits on the energy spread an energy recovery system can accept are discussed and a comparison is made with tapered wiggler systems.

5119 **Subharmonic triple buncher for a high-efficiency free electron laser.** Fraser, J.S. (AT-7 MS H821, Los Alamos Nat'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3115-3117(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A high-efficiency free electron laser oscillator experiment is being constructed at Los Alamos National Laboratory. A buncher system has been designed to deliver 30-ps, 5-nC electron bunches to a 20-MeV standing-wave linac at the 60th subharmonic of the 1300-MHz accelerator frequency. The first 108.3-MHz buncher cavity accepts a 5-ns, 5-A peak current pulse from a triode gun. Following a 120-cm drift space, a second 108.3-MHz cavity is used, primarily to enhance the bunching of the trailing half of the bunch. A 1300-MHz cavity with 20-cm drift spaces at each end completes the beamline components. The bunching process continues into the linac's first three accelerating cells. Two thin iron-shielded lenses and seven large-diameter solenoids provide axial magnetic fields for radial focusing.

5120 **Time-resolved electron beam diagnostics for the Los Alamos free-electron laser oscillator experiment.** Lumpkin, A.H.; Brau, C.A.; Fraser, J.S.; Warren, R.W. (Los Alamos Nat'l Lab., Univ. of Cal., P.O. Box 1663, Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3139-3141(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Measurement of the time-dependent electron beam energy distributions in the Los Alamos Free-Electron Laser (FEL) Oscillator Experiment will be accomplished by employing gated proximity-focussed microchannel-plate intensified vidicon cameras, an electron spectrometer employing a fluorescent target, and synchronized electron beam deflection techniques. General diagnostic system design features are described that provide information in the 30-ps, 50-ns, 10 μs, and 100-μs time regimes. These techniques provide a real-time electron micropulse optimization diagnostic and an on-line, time resolved measurement of the energy lost by the electrons within the optical cavity.

5121 **Spectrograph for free-electron laser experiments.** Kennedy, R.C.; Adamski, J.L. (Boeing Aerospace Co., Seattle, Washington 98124). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3142-3144(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The design and construction of a Browne-Buechner type round pole face magnetic electron spectrograph is described. The design is based on the first order transfer properties of the bending magnet including the focal surface, dispersion, magnification and resolution. Second order aberrations are compared wit numerical ray tracing results using measured field data to simulate the magnet. The numerical results are also compared with floating wire measurements on the system. Agreement is within one part in 10^4. Data extraction from the instrument is done with an array of copper detectors placed along the focal surface. The spectrograph has been successfully employed in free-electron laser (FEL) experiments for over a year.

5122 **Dispersion of the refractive index of GaAs and Al /SUB x/ Ga /SUB 1-x/ As.** Jensen, B.; Torabi, A. (Dept. of Physics, Boston University, Boston, MA 02215). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **19**: No. 5, 877-882(May 1983). Contract AC02-79ER10444.

The real part of the complex refractive index near the fundamental absorption edge is calculated for the ternary compound Al /SUB x/ Ga /SUB 1-x/ As, $0 \leqq x \leqq 0.3$, as a function of frequency. An analytical expression for n is given which is derived from a quantum mechanical calculation of the dielectric constant of a semiconductor assuming the band structure of the Kane theory. The expression obtained is a function of bandgap energy, effective electron and heavy hole masses, the spin orbit splitting energy, the lattice constant, and the carrier concentration for n-type or p-type materials. The refractive index at the absorption edge is found as a function of the material parameters above. This enables one to express theoretical results in terms of basic material parameters only, with no adjustable constants. Comparison of theory with available experimental data is given for various reported values of the bandgap energy and effective masses as functions of mole fraction x.

5123 **A soft x-ray streak camera.** Stradling, G.; Attwood, D.; Kauffman, R. (Los Alamos National Lab., Los Alamos, NM 87544). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **19**: No. 4, 604-615(Apr 1983). Contract W-7405-ENG-48.

A soft X-ray streak camera is presented which offers wide application for picosecond recording of transient signals in the spectral range from the VUV to the very hard X-ray region. Specific demonstration results are presented from laser-fusion diagnostic studies. Dynamic characterization of the streak camera, new photocathode studies, and the application of intermediate and broad spectral selectivity techniques are discussed.

5124 **Quantitative intensity measurements using a soft x-ray streak camera.** Kauffman, R.; Attwood, D.; Medecki, H.; Stradling, G. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **19**: No. 4, 616-621(Apr 1983). Contract W-7405-ENG-48.

A soft X-ray streak camera (SXRSC) has been calibrated in order to make absolute flux measurements of X-rays emitted from laser-produced plasmas. The SXRSC developed at the Lawrence Livermore National Laboratory and described in a companion paper in this issue is used to time-resolve X-ray pulses to better than 20 ps. The SXRSC uses an Au photocathode on a thin carbon substrate which is sensitive to X-rays from 100 eV to greater than 10 keV. Calibrations are done in the dynamic mode using a small laser-produced X-ray source. The SXRSC is calibrated by comparing its integrated signal to the output of calibrated X-ray diodes monitoring the source strength. Details of the experiment along with data from a typical calibration are presented. The measured SXRSC intensity response is linear over greater than two orders of magnitude. Using these calibrations, absolute intensities can be measured to an accuracy of + or - 30 percent. An example of its use as a flux monitoring device is presented.

5125 **Simultaneous determination of the spectral and temporal properties of tunable, single, picosecond pulses from a short cavity dye laser.** Scott, G.; Clark, J.; Cox, A.; Renz, G.; Tolbert, M.; Webb, S. (Dept. of Chemistry, Univ. of California, Riverside, CA 92521). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **19**: No. 4, 544-550(Apr 1983). Contract AC03-76SF00098;AM03-76SF00034.

The authors report simultaneous quantitative spectral and temporal measurements of the output pulses from a single-axial mode rhodamine 6G short cavity (1-8 μm) dye laser. The dye laser was pumped at 10 Hz with single second harmonic (532 nm) pulses from a mode-locked Nd^{+3}:YAG laser. Spectral measurements made with a high resolution spectrograph and temporal measurements made with an ultrafast streak camera indicate the production of Fourier transform limited pulses for near threshold operation. Output pulses of 7-14 ps (FWHM) are observed from the short cavity dye laser when pumped with 15-30 ps duration 532 nm pulses. The output pulse delay and jitter are also investigated. A theoretical model for the temporal evolution of the pulses is presented and compared with the experimental results.

5126 **Pulsed gain and thermal lensing of Nd: $LiYF_4$.** Murray, J.E. (Lawrence Livermore National Lab., Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **19**: No. 4, 488-490(Apr 1983). Contract W-7405-ENG-48.

Measurements show that a 1 cm diameter Nd:YLF rod amplifier produces extremely weak thermal lensing when pulse pumped at 3 Hz to a gain of 13 at 1053 nm. Direct comparison with Nd:YAG indicates much weaker thermal lensing effects for both ordinary and extraordinary polarizations in Nd:YLF.

4204 Heat Transfer And Fluid Flow

REFER ALSO TO CITATION(S) 4584

5127 **(N—8326796) Computational fluid dynamics: An engineering tool. Final Report.** Anderson, J.D., Jr. (Maryland Univ., College Park (USA)). Jun 1982. 11p. NTIS, PC A99/MF A01.

In a Collection of Papers in the Aerospace Sci. p 325-336 (SEE N83-26787 16-01).

Computational fluid dynamics in general, and time dependent finite difference techniques in particular, are examined from the point of view of direct engineering applications. Examples are given of the supersonic blunt body problem and gasdynamic laser calculations, where such techniques are clearly engineering tools. In addition, Navier-Stokes calculations of chemical laser flows are discussed as an example of a near engineering tool. Finally, calculations of the flowfield in a reciprocating internal combustion engine are offered as a promising future engineering application of computational fluid dynamics.

5128 **Experimental studies of heat transfer between a bundle of horizontal tubes and a gas-solid fluidized bed of small particles.** Grewal, N.S.; Saxena, S.C. (Mechanical Engineering Department, University of North Dakota, Grand Forks, North Dakota 58202). *Industrial and Engineering Chemistry Process Design and Development;* **22**: No. 3, 367-375(Jul 1983). Contract AC01-76ET10450.

Experimental data are obtained for heat transfer coefficient between electrically heated horizontal tube bundles (12.7 and 28.6 mm diameter) and square fluidized beds of silica sand ($\bar{}$d/rho/ = 167 and 504 μm) and alumina ($\bar{}$d/rho/ = 259 μm) as a function of air fluidizing velocity. The staggered tube bundle has its tubes located at the vertices of equilateral triangles with pitch varying between 1.75 to 9 times the tube diameter. Heat transfer data for a bundle of tubes are compared with a single tube under otherwise identical conditions and are compared with the existing correlations and theoretical models in the literature for maximum heat transfer coefficient. A correlation for the maximum heat transfer coefficient between horizontal tube bundles and a gas-solid fluidized bed of small particles ($75 < Ar < 20\,000$) is proposed which includes the influence of tube pitch in the bundle. The predicted values of the maximum heat transfer coefficient from the proposed correlation are generally within plus or minus 20% of the experimental data available in the literature when the contribution due to radiation is also included.

5129 **Heat transfer to gas-solids suspensions flowing concurrently downward in a circular tube.** Kim, J.M.; Seader, J.D. (Dept. of Chemical Eng., Univ. of Utah, Salt Lake City, UT 84112). *AIChE (American Institute of Chemical Engineers) Journal;* **29**: No. 2, 306-311(Mar 1983).

Heat transfer to a gas-solids suspension flowing cocurrently downward in a 13-mm inside diameter tube with uniform heat-flux boundary conditions was investigated using 329-μm spherical glass beads in air. The gas Reynolds number varied from 0 to 30,000 with solids-loading ratios of up to 20 at a gas Reynolds number of 10,000. The suspension Nusselt number, defined in terms of the wall-to-gas mixed-mean temperature difference, decreased with increasing solids-loading ratio at high Reynolds numbers, while it changed little from the value for gas alone at low Reynolds numbers. A possible explanation is given by considering the effects of particles on the fluid mechanical properties of the gas. Asymptotic Nusselt numbers in downflow are compared with results of other investigations for upflow.

5130 **Inertia effects of the dynamics of a disk levitated by incompressible laminar fluid flow.** Warinner, D.K.; Pearson, J.T. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, [Paper];* No. 83-GT-149, 11(1983). (CONF-830309—).

From 28. ASME international gas turbine conference; Phoenix, AZ, USA (27 Mar 1983).

This paper develops a nonlinear ordinary differential equation (O.D.E.) of motion for a disk parallel to a flat plate and levitated by incompressible laminar flow of fluid supplied from a central orifice. The fluid's inertia, reflected in high mass flow rates, is accounted for. The transient flow velocity and pressure field are found by iterative integration of the Navier-Stokes equation to determine the O.D.E. for the time-dependent height of the disk (or fluid film thickness). The film thickness is found by not only numerically integrating the O.D.E., but also by linearizing the equation to obtain a closed-form solution. The results of this combined squeezefilm, source-flow case compare favorably with experimental data presented which span cases from negligible inertia (viscous dominance) to cases of inertia dominance. Fortunately, the closed-form solution differs only slightly from the numerical solution; this provides relatively accurate expressions for the frequencies and

damping coefficients in terms of the geometry, load (or weight of disk), mass flow rate, and the fluid properties.

5131 **Theory and application of a three-dimensional code SHAPS to complex piping systems.** Wang, C.Y. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL.75**: 139-158(1983). (CONF-830607—).

This paper describes the theory and application of a three-dimensional computer code SHAPS to complex piping systems. The code utilizes a two-dimensional implicit Eulerian method for the hydrodynamic analysis together with a three-dimensional elastic-plastic finite-element program for the structural calculation. A three-dimensional pipe element with eight degrees of freedom is employed to account for the hoop, flexural, axial, and the torsional mode of the piping system. In the SHAPS analysis the hydrodynamic equations are modified to include the global piping motion. Coupling between fluid and structure is achieved by enforcing the free-slip boundary conditions. Also, the response of the piping network generated by the seismic excitation can be included. A thermal transient capability is also provided in SHAPS. An energy equation is used to compute the coolant temperatures due mainly to the heat convection. This equation is linked together with a radial heat conduction equation to establish the temperature profile throughout the pipe-wall thickness. Thermal mechanical stresses are calculated by a thermo-viscoplasticity constitutive equation. The flow stress is then determined by an associated flow rule via Newton-Raphson procedure. To illustrate the methodology, many sample problems dealing with the hydrodynamic, structural, and thermal analyses of reactor-piping systems are given. Validation of the SHAPS code with experimental data is also presented.

5132 **Measurement of crossflow forces on tubes.** Mulcahy, T.M. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, [Paper];* No. 83-PVP-77, 7(1983). (CONF-830607—). Contract W-31-109-ENG-38.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

A force transducer for measuring lift and drag coefficients for a circular cylinder in turbulent water flow is presented. In addition to describing the actual design, requirements for obtaining valid fluid force test data are discussed, and pertinent flow test experience is related.

5133 **Biofouling monitors for noncylindrical OTEC heat exchanger tubes.** Kuzay, T.M.; Gavin, A.P.; Panchal, C.B. (Argonne National Laboratory, Argonne, IL 60439). *Journal of Solar Energy Engineering;* **104**: No. 3, 257-261(Aug 1982).

Heat-transfer monitors (HTMs) have been used to measure the reduction in the seawater heat-transfer coefficient due to build-up of biofouling and corrosion products inside circular tubes of shell-and-tube heat exchangers being developed for ocean thermal energy conversion (OTEC) plants. For OTEC heat exchangers (HXs) with other tube geometries, special, modified HTMs, which we call STMs, are being sought. The analytical approaches and calibration results to date are summarized for STMs of two types: (i) an STM simulating a rectangular seawater passage in a compact, aluminum, plate-fin HX, and (ii) an STM for a helical stainless-steel tube. The development of type 1 has been successful. A software change is needed for type 2.

5134 **Hydrodynamics of annular-dispersed flow.** Ishii, M.; Kataoka, I. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* No. PVP-VOL. 64, 1-18(1982). (CONF-820601—).

The interfacial drag, droplet entrainment, and droplet size distributions are important for detailed mechanistic modeling of annular dispersed two-phase flow. In view of this, recently developed correlations for these parameters are presented and discussed in this paper. The drag correlations for multiple fluid particle systems have been developed from a similarity hypothesis based on the mixture viscosity model. The results show that the drag coefficient depends on the particle Reynolds number and droplet concentration. The onset of droplet entrainment significantly alters the mechanisms of mass, momentum, and energy transfer between the film and gas core flow as well as the transfer between the twophase mixture and the wall. By assuming the roll wave entrainment mechanism, the correlations for the amount of entrained droplet as well as for the droplet size distribution have been obtained from a simple model in collaboration with a large number of data. The comparison of the correlations to various data show satisfactory agreement.

5135 **Simulation of thermal transient induced pipe flow stratification using COMMIX-2.** Shah, V.L.; Domanus, H.M.; Miao, C.C.; Schmitt, R.C.; Sha, W.T. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* No. PVP-VOL. 64, 91-105(1982). (CONF-820601—).

At low-flow (high Richardson number) in a piping system with thermal-transient, we have thermal buoyancy induced secondary flows. Three-dimensional computer codes are, therefore, necessary to model correctly the non-axisymmetric, thermally stratified flow through a piping system. This paper presents the results of the numerical simulation of thermal-hydraulic behavior in a pipe during a thermal transient. The particular transient considered was the experimental test # PIPE2, and carried out at the Mixing Components Test Facility (MCTF), Argonne National Laboratory. The numerical simulation was performed using COMMIX-2. COMMIX-2 is a computer code for steady/unsteady, three-dimensional, two-phase thermal-hydraulic analysis of reactor components under normal and off-normal operating conditions. The results of simulation are compared with the experimental measurements, and they are in reasonable agreement with experimental data.

5136 **Some aspects of fluid-structure coupling.** Kulak, R.F. (Argonne National Laboratory, Argonne, IL). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* No. PVP-VOL. 64, 244-260(1982). (CONF-820601—).

The numerical simulation of nonlinear, transient fluid-structure interactions (FSI) is a current area of concern by researchers in various fields, including the field of nuclear reactor safety. This paper primarily discusses the formulation used in an algorithm that couples three-dimensional hydrodynamic and structural domains. The fluid domain is governed by the Navier-Stokes equations, and the structural domain is governed by the equations of nonlinear structural dynamics. Here, both the fluid and structure are discretized using finite elements. The fluid is discretized with eight-noded quasi-Eulerian hexahedrons and the structural components are represented by Lagrangian triangular plate elements. The semi-discretized equations of motion are solved using an explicit temporal integrator. The coupling is accomplished by satisfying interface mechanics. The structure imposes kinematic constraints to the moving fluid boundary, and the fluid in turn provides an external loading on the structure. At each interface node, normals are computed from the nodal basis functions of only the hydrodynamic nodes. By defining the interface normal in this manner, it becomes independent of the type of structural boundary (i.e. shell, plate, continuum etc.) and thus makes this aspect of the coupling independent of the structure type. Results for several problems are presented and these include a comparison between analytical results for a FSI problem and numerical predictions.

4205 Materials Testing

REFER ALSO TO CITATION(S) 5126, 5146, 5353

5137 **(SAND—83-1141C) Sensitivity and accuracy analysis of pulse diffusivity measurements on layered samples.** Koski, J.A. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 20p. (CONF-8310163—9). NTIS, PC A02/MF A01. Order Number DE84002104.

From 18. international thermal conductivity conference; Rapid City, SD, USA (3 Oct 1983).

Measurement by the laser pulse technique of the thermal diffusivity of an unknown layer in a planar layered sample consisting of two or three materials requires knowledge of the thermal properties and thicknesses of the remaining sample layers. This paper examines the sensitivity of the technique to uncertainties in the known parameters of the adjacent layers and applies the results of the sensitivity analysis to the topic of sample selection and assessment of the overall accuracy of the calculated thermal diffusivity.

5138 **(SAND—83-2326C) Computed tomography status.** Hansche, B.D. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 20p. (CONF-8310217—1). NTIS, PC A02/MF A01. Order Number DE84002801.

From WANTO meeting; Miamisburg, OH, USA (10 Oct 1983).

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Computed tomography (CT) is a relatively new radiographic technique which has become widely used in the medical field, where it is better known as computerized axial tomographic (CAT) scanning. This technique is also being adopted by the industrial radiographic community, although the greater range of densities, variation in samples sizes, plus possible requirement for finer resolution make it difficult to duplicate the excellent results that the medical scanners have achieved.

5139 **(UCRL—50025-83-2) EE technical review. Special issue: flash x-ray accelerator.** (Lawrence Livermore National Lab., CA (USA)). Aug 1983. Contract W-7405-ENG-48. 24p. NTIS, PC A02/MF A01. Order Number DE84002348.

Improvements to the pulsed power system of FXR made during the past year have resulted in much better reliability and repeatability. At a current level of 2.2 kA on target, the machine produces a radiation dose of 480 R at 1 m, with a spot size of 3 to 5 mm and with the dose repeatable within +- 10%. With this new capability, researchers have already begun to improve their understanding of material behavior at high pressure and densities, working in a heretofore inaccesible regime of radiographic penetration and resolution.

5140 **(UCRL—89635) Maximum entropy methods in electromagnetic/geophysical/ultrasonic imaging.** Bevensee, R.M. (Lawrence Livermore National Lab., CA (USA)). Oct 1983. Contract W-7405-ENG-48. 27p. (CONF-8309184—1). NTIS, PC A03/MF A01. Order Number DE84002793.

From NATO Advanced Research Institute conference on inverse methods in electromagnetic imaging; Bad Windsheim, F.R. Germany (18 Sep 1983).

Maximum Entropy (ME) methods of resolving underdetermined electromagnetic images are reviewed. A new non-Burg method of resolving complex amplitudes of coherent radiators in wave-number space (direction) is described. Several ME methods in geophysics are surveyed, based on Burg's method for spatial array data processing and a Boltzmann method for parameter distributions in the earth. A Boltzmann-ME method is described for resolving anomalies in materials ultrasonically, where the data is governed by a Fredholm integral equation of the second kind. Some issues or uniqueness, confidence, and noise are briefly assessed.

5141 **Ultrasonic probe for inspecting double-wall tube.** Cook, K.V.; Cunningham, R.A. Jr.; Murrin, H.T. (to US Department of Energy). US Patent 4,391,143. 5 Jul 1983. Filed date 29 May 1981. vp.

An ultrasonic probe is disclosed for inspecting the interface between the walls of a double-wall tube comprises a cylindrical body member having two cavities axially spaced apart thereon. The probe is placed in the tube and ultrasonic energy is transmitted from a transducer in its body member to a reflector in one of its cavities and thence into the inner wall of the tube. A second transducer in the probe body member communicates with the second cavity through a collimation passage in the body member, and the amount of ultrasonic energy reflected from the interface between the walls of the tube to a second reflector through the collimation passage to the second transducer depends upon the characteristics of said interface.

5142 **On the definition of microhardness.** Yost, F.G. (Sandia National Laboratories, Albuquerque, NM 87185). *Metallurgical Transactions, [Section] A: Physical Metallurgy and Materials Science;* **14A**: 947-952(May 1983). Contract AC04-76DP00789.

Microhardness testing can be a very useful tool for studying modern materials, but is plagued by well-known experimental difficulties. Reasons for the unusual behavior of hardness data at very low loads are explored by Monte Carlo simulation. These simulations bear remarkable resemblance to the results of actual hardness experiments. The limit of hardness as load or indentation depth tends to zero is shown to depend on experimental error rather than upon intrinsic material properties. The large scatter of hardness data at very low loads is insured by the accepted definition of hardness. A new definition of hardness is suggested which eliminates much of this scatter and possesses a limit as indentation depth approaches zero. Some simple calculations are used to show the utility of this new approach to hardness testing.

5143 **Measurement of residual stresses by ultrasonic attenuation.** Emery, A.F.; Goods, S.H.; Thomas, G.H. (Univ. of Washington, Seattle, WA). *American Society of Mechanical Engineers, [Paper];* No. 83-PVP-31, 11(1983). (CONF-830607—). Contract AC04-76DP00789.

From American Society of Mechanical Engineers pressure vessel and piping conference; Portland, OR, USA (19 Jun 1983).

Ultrasonic wave attenuation measurements made on aluminum single crystals and other materials suggest that such techniques can be used to measure the permanent strain and residual stresses induced by inhomogenous plastic deformation. This paper describes the basis of this technique and the results of an experimental program to determine the material constants needed for its use. The results show that attenuation can be used as an indication of plastic strain and of the effectiveness of stress relieving operations. The method also appears to have value in measuring the stress existing in annealed materials, but its use for residual stress measurement needs further development.

5144 **A procedure to evaluate structural adequacy of a piping system in creep range.** Dhalla, A.K. (Westinghouse Advanced Reactors Division, Madison, PA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **PVP-VOL. 66**: 47-60(1982). (CONF-820601—).

An inelastic analysis procedure to establish structural adequacy of an elevated temperature piping system is presented in this paper. The analytical method is incidental to the procedure used to comply with Code Case N-47 inelastic strain accumulation and creep-fatigue damage criteria.

4207 Vacuum Engineering

REFER ALSO TO CITATION(S) 5290

5145 **Vacuum arc anode phenomena.** Miller, H.C. (General Electric Co., Neutron Devices Dept., St. Petersburg, FL 33733). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **11**: No. 2, 76-89(Jun 1983). Contract AC04-76DP00656.

This paper briefly reviews anode phenomena in vacuum arcs, specially experimental work. It discusses, in succession, arc modes at the anode, anode temperature measurements, anode ions, transitions of the arc into various modes (principally the anode spot mode), and theoretical explanations of anode phenomena. The two most common anode modes in a vacuum arc are a low current mode where the anode is basically passive, acting only as a collector of particles emitted from the cathode, and a high current mode with a fully developed anode spot. Characteristically this anode spot has a temperature near the atmospheric boiling point of the anode material and is a copious source of vapor and energetic ions. However, other anode modes can exist. The dominant mechanism controlling the transition of the vacuum arc into the anode spot mode depends upon the electrode geometry, the electrode material, and the current waveform of the particular vacuum arc being con-

sidered. In specific experimental conditions either magnetic constriction in the gap plasma or gross anode melting or local anode evaporation can trigger the transition. However, the most probable explanation of anode spot formation is a combination theory, which considers magnetic constriction in the plasma together with the thermal, electrical, and geometric effects of the anode in analyzing the interaction between the gap plasma near the anode and the anode itself.

4208 Electronic Circuits And Devices

REFER ALSO TO CITATION(S) 5046

5146 **(GEPP-TIS—739) Glass tube cracking, vacuum tube/transformer assembly.** Gillespie, T.J. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 14 Nov 1983. Contract AC04-76DP00656. 26p. NTIS, PC A03/MF A01. Order Number DE84003852.

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An assessment of the stress in an encapsulated vacuum tube-transformer assembly included: stress required to crack a tube, stress due to encapsulation, and stress due to temperature cycling. Both strain gage and photoelastic techniques were used for this stress analysis. Evaluation of the results indicated that a highly stressed tube cracked at either encapsulation or during temperature cycling. When cracking occurred as a result of encapsulation, the encapsulant was bonded to the transformer core.

5147 **(NRL-Memo—5185) BERTHA: a versatile transmission line and circuit code.** Hinshelwood, D.D. (Naval Research Lab., Washington, DC (USA)). 21 Nov 1983. Contract AI08-79DP40092. 98p. NTIS, PC A05/MF A01. Order Number DE84002984.

An improved version of the NRL transmission line code of W.H. Lupton is presented. The capabilities of the original program have been extended to allow magnetically insulated transmission lines, plasma opening switches, imploding plasma loads and discrete element electrical networks, for example, to be modeled. BERTHA can be used to simulate any system that can be represented by a configuration of transmission line elements. The electrical behavior of the system is calculated by repeatedly summing the reflected and transmitted waves at the ends of each element. This program is versatile, easy to use and easily implemented on desktop microcomputers.

5148 **(SAND—82-1824) SNAP: Sandia Node Accessibility Program. A user's guide.** Acken, C.F. (Sandia National Labs., Albuquerque, NM (USA)). Oct 1983. Contract AC04-76DP00789. 84p. NTIS, PC A05/MF A01. Order Number DE84003149.

The primary purpose of the Sandia node Accessibility program (SNAP) is to analyze the testability of an IC by computing a set of measures for each node in the circuit. It is based upon the Sandia Controllability Observability Analysis Program (SCOAP) which was a feasibility demonstration of testability analysis. The SNAP measures indicate the difficulty of selecting primary input values which will set an internal node to logical zero or logical one, and the difficulty of propagating a logic value on an internal node to a primary output. Using these measures, the designer can locate nodes in the circuit which will be dificult to test, and can modify the design to increase the ease of test generation. The altered dwsign can then be analyzed for testability. Iterative improvement upon the design with respect to testability is possible. The designer is allowed to determine the point in the iterative process at which an acceptable level of testability has been reached.

5149 **(SAND—83-1400C) Comparison of thermal, line-source electron beam and CW laser annealing for the fabrication of $ErSi_2$ Schottky barrier on Si.** Wu, C.S.; Scott, D.M.; Lau, S.S.; Wakita, A.; Sigmon, T.W.; Knapp, J.A.; Picraux, S.T. (California Univ., San Diego, La Jolla (USA); Stanford Univ., CA (USA). Stanford Electronics Labs.; Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 13p. (CONF-831174—11). NTIS, PC A02/MF A01. Order Number DE84003105.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

$ErSi_2$ contacts formed by reacting Er with single crystal silicon using conventional furnace heat treatment are dominated by pits. Recently rapid electron and laser beam heating have been used to form pit-free $ErSi_2$ layers on Si by reacting Er with the Si substrate. For this investigation we studied the electrical properties of erbium silicide/Si<p,100> contact prepared by thermal, laser and electron beam annealing. We prepared and annealed three types of samples; (I) Er(600A)/Si<p,100), (II) Si(100A)/Er(600A)/Si<p,100> and (III) Si(900A)/Er(600A)/Si<p,100>. The barrier height of the pit-free thermal annealed samples (type III) was ~ 0.78 eV. All laser and e-beam annealed samples were observed to be pit free. The barrier heights for the laser annealed samples varied from ~ 0.63 eV for type I samples to ~ 0.77 eV for type III samples. The eV (type I and II) and ~ 0.77 eV for type III. The barrier heights of beam processed diodes shifted towards the 0.78 eV range upon post-annealing. We model these results in terms of defects created at the $ErSi_2$-Si interface.

5150 **(UCRL—89147) Modeling and testing for second breakdown phenomena.** Orvis, W.J.; McConaghy, C.F.; Yee, J.H.; Khanaka, G.H.; Martin, L.C.; Lair, D.L. (Lawrence Livermore National Lab., CA (USA)). Sep 1983. Contract W-7405-ENG-48. 11p. (CONF-8309162—2). NTIS, PC A02/MF A01. Order Number DE84002470.

From 5. annual EOS/ESD symposium; Las Vegas, NV, USA (27 Sep 1983).

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We have developed a number of computer models at the Lawrence Livermore National Laboratory, to study the operation of semiconductor devices during an Electromagnetic Pulse (EMP) induced transient. During the last year, two of these models have been giving significant results. A simplified transistor model has been used to calculate second breakdown effects in a transistor like structure. This simple, n^+-p-n-n^+ one-dimensional model uses analytical approximations in all regions except for the n-region where numerical solutions are obtained. Using this model, we have investigated the differences between current mode and thermal mode second breakdown (described previously, Ref. 1) and a switching effect between current mode and thermal mode second breakdown. Our second model is a complete, one-dimensional model of a p-n junction device. This model performs numerical solutions over the whole device structure, providing detailed insight into the physical phenomena that make up second breakdown. As a final part, we will describe some experimental results that show a voltage dependence of the delay time to breakdown, and a decreasing failure energy with decreasing pulse length in the short pulse regime (1 to 10 ns).

5151 **(SLAC-Trans—0205) Impregnated cathodes.** Shroff, A.M.; Palluel, P. Translated from *Revue Technique Thomson-CSF ;* **14**: No. 3, 583-655(Sep 1982). Contract AC03-76SF00515. 63p. NTIS, PC A04/MF A01. Order Number DE84002670.

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This article reviews the various so-called dispenser type therminonic cathodes, which are the most widely used in microwave tubes and, more recently, in cathode-ray tubes. The authors give a brief background history in order to situate the problem in the present context, and describe the manufacturing technology used for the different types of cathodes. The electronic emission characteristics are studies on the basis of the emission laws in the space charge and saturation modes, and various devices and test equipment for conducting short and long term measurements are described. The authors then consider the physico-chemical aspect of the emitter material: preparation, production of the active material in the porous body, its evaporation rate measured by different methods in terms of time and temperature. Analysis methods such as by scanning electron microscope, Auger and ESCA spectroscopy and x-ray diffraction are used to highlight crystalline structure and surface composition of these cathodes during operation at various stages in their life. A theoretical and practical analysis of the durations obtained with test diodes was carried out, and the authors deduce from it correlations concerning the way in which emission varies with time and temperature.

Lastly, the authors describe and discuss various models that are representative of the operation of dispenser-type cathodes.

5152 **(DOE-tr—4002304) Influence of doping with In and Ga and with In + Cl and Ga + Cl on the photoconductivity of CdS sinter layers.** Zoellei, M. Translated from *Acta Physica et Chemica ;* **12**: No. 1-2, 21-25(1966). Contract AC02-83CH10093. 8p. NTIS, PC A02/MF A01. Order Number DE84002304.

The chemical sensitization procedure was used to incorporate In, Ga and In + Cl and Ga + Cl into CdS photoresistors. CdS layers with a large photoelectric area and a high degree of light sensitivity can be produced by using the doping mentioned above. The resistance and sensitivity of the CdS layers can be varied by several orders of magnitude through changing the doping concentration as well as the temperature and duration of annealing. The light sensitivity of a doped layer exceeds that of an undoped one by 3 to 4 orders of magnitude. The layers are very stable and retain their properties even after loads of long duration. The light sensitive area can measure several cm^2.

4210 Combustion Systems

5153 **(DOE/ER/04433—T1) Theoretical studies on heterogeneous combustion. Final report, July 1, 1977-June 30, 1983.** Law, C.K. (Northwestern Univ., Evanston, IL (USA)). Oct 1983. Contract AC02-77ER04433. 24p. NTIS, PC A02/MF A01. Order Number DE84003178.

The complex processes occurring within liquid-fueled chemical combustors utilizing spray injection techniques are basically heterogeneous in nature, involving the vaporization, ignition, combustion, extinction, and motion of an ensemble of droplets which interact with gaseous medium. The present program aims to gain fundamental understanding on the influence of the kinetic and transport processes on heterogeneous, diffusional, combustion in general, and droplet and spray burning in particular. The multicomponent nature of practical fuel blends has also been addressed. A total of twenty journal articles have been prepared summarizing results of the present investigation.

5154 **(N—8325841) A new combustion system for burning light distillate fuel oil.** Eickhoff, H. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.)). Sep 1982. 20p. (DFVLR-MITT—83-01). NTIS, PC A02/MF A01.

In Panel Meeting and 16th Intern. Flame Res. Found. Meeting, San Donato Milanese, Italy.

A controllable small air blast burner unit was developed which works well in the power range necessary for an optimum operation with regard to the overall efficiency of a residential heating system. The polluant emissions, CO as well as NO are low. Due to the nature of the system the air pressure drop is far above that of conventional domestic burners. Present development of the combustion system is mainly directed towards a reduction of the air pressure drop and the amount of excess air.

5155 **Evaluation of advanced combustor concepts for dry NO/sub x/ suppression with coal-derived, gaseous fuels.** Beebe, K.W.; Notardonato, J.; Symonds, R.A. (General Electric Company, Schenectady, NY). *American Society of Mechanical Engineers, [Paper];* No. 83-GT-14, 12(1983). (CONF-830309—).

From 28. ASME international gas turbine conference; Phoenix, AZ, USA (27 Mar 1983).

This paper presents the results of testing two combustion systems--the gas-fueled rich-lean combustor and the catalytic combustor--for fuel efficiency and emission levels. A lean-lean combustor was also briefly investigated. The rich-lean combustor, in the single configuration tested, did not significantly reduce thermal nitrous oxides emission for the baseline gas fuel having a lower heating value of 244 Btu/scf (10.3 MJ/NCM). Aside from this drawback, the combustor provided generally satisfactory performance for all other important combustion parameters including co emissions, smoke, pattern factor, pressure drop, metal temperatures, ignition, turndown, and post-test condition. Test results indicate that the lean-lean combustor concept has the potential to achieve ultra-low nitrous oxides emissions for liquid and gas fuels having no fuel-bound nitrogen. The catalytic combustor demonstrated the potential for very low nitrous oxides emissions burning distillate fuel. The catalytic reactor can be ignited easily at the compressor discharge temperatures available in present-day gas turbines. Parallel staging of the catalyst with a conventional design requires careful control of airflow splits and catalyst pressure drop. Use of variable-geometry devices to control airflow distribution to the reactor and pilot stages are necessary for the parallel-design approach. General Electric has completed the preliminary design of a series-staged combustor which will avoid flow-split instabilities encountered in the tests.

5156 **Multifuel evaluation of rich/quench/lean combustor.** Novick, A.S.; Notardonato, J.; Troth, D.L. (Detroit Diesel Allison, Division of General Motors Corporation, Indianapolis, Indiana). *American Society of Mechanical Engineers, [Paper];* No. 83-GT-140, 8(1983). (CONF-830309—).

From 28. ASME international gas turbine conference; Phoenix, AZ, USA (27 Mar 1983).

The work described in this paper is a part of the DOE/LeRC "Advanced Conversion Technology Project (ACT). The program is a multiple contract effort with funding provided by the Department of Energy and Technical Program Management provided by NASA LeRC. The emphasis in this paper is the fuel flexible combustor technology developed under the "Low NO/SUB x/ Heavy Fuel Combustor Concept Program" for application to the Detroit Diesel Allison (DDA) Model 570-K industrial gas turbine engine. The technology, to achieve emission goals, emphasizes dry fuel-bound nitrogen (FBN), and control of NO/SUB x/ effected through a stated combustor with a rich initial combustion zone. A rich/quench/lean (RQL) variable geometry combustor utilizes the technology that is presented to achieve low NO/SUB x/ from alternate fuels containing FBN. The results focus on emissions and durability for multifuel operation.

5157 **Combustion characteristics of hydrogen - carbon monoxide-based gaseous fuels.** White, D.J.; Kubasco, A.J.; Lecren, R.T.; Notardonato, J.J. (Solar Turbines Incorporated, San Diego, California). *American Society of Mechanical Engineers, [Paper];* No. 83-GT-142, 12(1983). (CONF-830309—).

From 28. ASME international gas turbine conference; Phoenix, AZ, USA (27 Mar 1983).

An experimental rig program has been conducted with the objective of evaluating the combustion performance of a family of fuel gases based on a mixture of hydrogen and carbon monoxide. These gases, in addition to being members of a family, were also representative of those secondary fuels that could be produced from coal by various gasification schemes. In particular, simulated Winkler, Lurgi, and Blue-water low and medium energy content gases were used as fuels in the experimental combustor rig. The combustor used was originally designed as a low NOx rich-lean system for burning liquid fuels with high bound nitrogen levels. When used with the above gaseous fuels this combustor was operated in a lean-lean mode with ultra long residence times. The Bluewater gas was also operated in a rich-lean mode. The results of these tests indicate the possibility of the existence of an "optimum" gas turbine hydrogen - carbon monoxide based secondary fuel. Such a fuel would exhibit low NOx and high efficiency over the entire engine operating range. It would also have sufficient stability range to allow normal light-off and engine acceleration. Solar Turbines Incorporated would like to emphasize that the results presented here have been obtained with experimental rig combustors. The technologies generated could, however, be utilized in future commercial gas turbines.

4220 Underground Engineering

5158 **Rheology of foam and its implications in drilling and cleanout operations.** Sanghani, V.; Ikoku, C.U. (Johnston-Macco Schlumberger, Lafayette, Louisiana). *American Society of Mechanical Engineers, [Paper];* No. 83-PET-31, 12(1983). Contract AC19-79BC10079.

Experimental analysis was carried out to study the rheological properties of foam. Foam was generated by simultaneously injecting air and an aqueous solution of the foaming agent through a coiled tubing foam generator. Foam was injected at the bottom of an annulus with 4.0 in. (I.D.) casing diameter and 1.5 in. (O.D.) tubing diameter. Qualities ranged from 0.65 to 0.95. Shear rates ranged from 150 to 1000 sec^{-1}. Effective viscosities were calculated and were found to range from 60 to 500 cps. Results showed that flowing foam behaved as a pseudo plastic fluid with no yield value; effective foam viscosity decreased with an increase in shear rate for a fixed quality. For shear rates in the range 500 sec^{-1} to 1000 sec^{-1}, the effective foam viscosity was independent of foam quality. This is useful since most field applications fall in this range.

4230 Marine Engineering

REFER ALSO TO CITATION(S) 5440, 5441, 5442, 5443

5159 **New systems for offshore geotechnical investigations.** Zuidberg, H.M. (FUGRO, Leidschendam, Netherlands). pp 995-1009 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

The investigtion of the seabottom for the purpose of foundation design of offshore structures is mainly done by drilling holes in which samples of the soil are obtained or the soil is tested in-situ. The quality of the soil investigation depends very much on the vertical stability of the drillstring during testing or sampling. In this paper new developments controlling this stability are discussed, namely: a guide base with a pipeclamp system, and a drillstring anchor in the form of a rough hole packer. 15 figures.

5160 **Advanced sea-bed tooling and instrumentation for sea-bed vehicles.** Murray, I.; Cameron, G. (UDI Group Ltd., Aberdeen, England). pp 1241-1264 of New technologies for exploration and exploitation of oil and gas resources. Volume 2. London, England; Graham and Trotman Limited (1979). (EUR—6299-EN-FR-Vol.2; CONF-7904180—Vol.2).

From Symposium on new technologies in the development of oil and gas resources; Luxembourg, Luxembourg (18 Apr 1979).

U.D.I. OPERATIONS LTD. have produced a seabed contact vehicle Seabug. Since the vehicle became operational effort has been put into producing the tooling and instrumentation required to make a useful working vehicle. The tools being developed consist of a purpose built handling system, a simple manipulator, optical pan and tilt unit, pipe burial tool, stereo television system, pipe tracking and depth of bury system, scanning sonar unit, microprocessor control system and investigation into the problems of traction in areas with very soft material. This development of tooling for Seabug is being supported by the European Economic Community. The successful conclusion of this project will result in a significant sea bed work capability for Seabug. 9 figures.

43 PARTICLE ACCELERATORS

4301 Design, Development, And Operation

REFER ALSO TO CITATION(S) 5662

5161 **The major accelerator projects in China.** Jialin, Xie. (Inst. of High Energy Physics, Academia Sinica, P.O. Box 918, Beijing). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1962-1966(Aug 1983).

The development of accelerators in China began after the founding of the Republic in 1949. Among the milestones are a Van de Graaff of 2.3 MV in 1959, a 25 MeV betatron in 1963, a 1.2m cyclotron and an electron linear accelerator of 30 MeV together with its 14 MW high power klystron in 1964, and a 10 MeV proton linac in 1982. Some medium and high energy accelerators are currently under construction. The major projects are the Beijing Electron Positron Collider of 2.2 to 2.8 GeV, the Lanzhou Heavy Ion Research Facility of 100-5 MeV/A, and the Hefei Synchrotron Radiation Laboratory of 800 MeV. These projects and their purposes are described.

5162 **The Fermilab antiproton source.** Peoples, J. (Fermi Nat.'l Accelerator Lab., P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1970-1975(Aug 1983).

Fermilab has begun construction of a proton-antiproton collider, the Tevatron I Project, whose goal is to achieve proton-antiproton collisions at 2 TeV in the center of mass at a luminosity greater than 10^{30} cm^{-2} sec^{-1}. The project consists of the adaptation of the Energy Saver to a 1 TeV storage ring, modification of the existing Main Ring, and construction of an Antiproton Source. In order to achieve peak luminosity in the Energy Saver, the Antiproton Source must be able to accumulate 2 X 10^{11} antiprotons (p's) within a lifetime that is shorter than or comparable to the luminosity lifetime. This paper presents the design method meant to achieve this, examines the operation of the Antiproton Source, outlines the construction schedule of the overall project, and justifies theoretically and experientially the selected p production mode.

5163 **The status of the SLAC Linear Collider project.** *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1976-1977(Aug 1983). Contract AC03-76SF00515.

The SLAC Linear Collider Project (SLC) has two principal goals: to serve as a prototype for a future very high energy linear electron-positron collider and to achieve, at low cost, sufficient luminosity at 100 GeV center-of-mass energy to explore the physics of the Z^0. At the design luminosity of 6.0 X 10^{30} many thousands of Z^0 decays should be observed for each operating day. The SLC design parameters, including center-of-mass energy, energy spread, repetition rate, particles per electron-positron bunch, emittance at 50 GeV, beam size at collision point, and luminosity, are presented in this paper, as well as the specifications, construction, and performance rating of supporting systems such as the klystron and storage ring.

5164 **The LEP project - status and plans.** Plass, G. (European Organization for Nuclear Research - CERN, 1211 Geneve 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1978-1982(Aug 1983).

The LEP Project, in modified form, was approved at the end of 1981 by the CERN Council and is now in the final design and construction phase. The modifications included reducing the LEP circumference from 30.6 to 26.6 km and increasing the betatron advance at high energy from 60° to 90° per lattice period. While the asymptotic beam energy was only reduced by 4%, substantially less than the consequent cost saving, the main advantage of this ring size reduction was in moving the tunnel out from under the Jura mountains. A subsequent displacement took the tunnel still farther away from the 1000 meter overburden of the Jura Crest. After exploratory drilling the depth of the LEP was determined so that 90% of the tunnel would lie in molasse rock. The resulting design and output parameters are presented in this paper.

5165 **Coupled operation experience at the Holifield heavy ion research facility.** Lord, R.S.; Ball, J.B.; Hudson, E.D.; Kloeppel, P.K.; Ludeman, C.A.; Martin, J.A.; Mosko, S.W.; Ziegler, N.F. (Oak Ridge Nat.'l Lab., Oak Ridge, Tennessee 37830). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2077-2079(Aug 1983). Contract W-7405-ENG-26.

The 25URC Pelletron tandem electrostatic accelerator and the Oak Ridge Isochronous Cyclotron (ORIC) comprise the accelerators of the Holifield Heavy Ion Research Facility (HHIRF). The two machines may be operated individually or coupled; ORIC serves as an energy booster for the tandem. In the coupled mode the ion beam enters the cyclotron through the dee stem and is directed by the inflection magnet so that it is tangent to an orbit suit-

able for acceleration at a higher charge state. This fraction of the beam is then accelerated and extracted in the normal fashion. Full energy performance (25 MeV/A oxygen) was demonstrated during the first coupled operation in January 1981. Routine coupled operation for experiments commenced in July 1982. This paper presents diagrams and descriptions of the design and operating parameters.

5166 **The proposed Univ. of Manitoba polarised and unpolarised light ion facility.** Oh, S.; Derenchuck, V.; Gusdal, I.; Konopasek, F.; McIlwain, A.; McKee, J.S.C.; Pogson, R. (Cyclotron Lab., Univ. of Manitoba, Winnipeg, Manitoba, R3T 2NZ). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2089-2091(Aug 1983).

A variable energy cyclotron with six separated sectors is proposed for the acceleration of polarized and unpolarized light positive and negative charge state ions. The energy range within which these ions are accelerated and extracted is given. The requirements for beam current and quality are that the accelerator should deliver high level beams with good energy resolution; the specifics of these requirements are included. The depolarization of polarized beams during acceleration should be negligible for all particles. It is proposed that the beam be injected from an external ion source at a low energy of ca. 200 KeV rather than from a pre-accelerator. The acceleration of H^- and D^- particles entails losses through collisional electron detachment and electromagnetic stripping inside the cyclotron. The loss from the former is expected to be ca. 10% for D^- at 10^{-7} Torr while the loss from the latter is estimated at ca. 0.04% for H^-. The design parameters are presented and justified in this paper.

5167 **Preliminary design of the NRL modified betatron.** Golden, J.; Altes, R.; Champney, P.; Fliflet, A.; Kapetanakos, C.A.; Mako, F.; Mora, F.; Orrick, N.; Pasour, J.; Pershing, D.E. . (Naval Research Lab., Washington, DC, 20375). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2114-2116(Aug 1983).

The principal subsystems of the NRL Modified Betatron Accelerator have been designed. These subsystems include the air-core magnets, the mechanical structure, the vacuum system, the injector accelerator, and the pulse power capacitor banks. The betatron concept uses an applied toroidal magnetic field to improve the stability and confinement of a multikiloamp electron beam. Trapping of an injected beam will result from varying the B /SUB z/ by a few Gauss during the first poloidal bounce period. Externally driven coils will compensate the diffusion of the self magnetic field to maintain equilibrium.

5168 **A variable transition energy lattice for SIS 12/18.** Franezak, B.; Blasche, K. (GS1, Postfach 110 541, D-6100 Darmstadt 11). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2120-2122(Aug 1983).

GSI plans to build a heavy ion synchrotron, the SIS 12/18, as an extension to its UNILAC facility. This linear accelerator, in operation since 1976, accelerates heavy ions up to 20 GeV/u; SIS will extend this range up to 1 GeV/u for the heaviest ions such as uranium (q/A ca. 0.3) and up to 2 GeV/u for light ions with a specific charge of q/A = 0.5. Acceleration of intense proton beams to 4.5 GeV is being discussed as an option, for the production, for instance, of exotic radionuclides, or for experiments comparing proton interactions with those of ions. In normal operation a magnetic rigidity of 12 Tm can be reached in a fast cycle (dB/dt = 10 T/s, 3 cycles/s). For high energy operation up to 18 Tm, the power supplies are connected to give a peak current of 3500 A at a reduced cycle rate (dB/dt = 4 T/s, 1 cycle/s). The use of triplet focusing at low energy increases machine acceptance. Modulation of the doublet current raises transition energy when accelerating protons to 4.5 GeV. This paper presents and justifies the design and operating parameters.

5169 **Status of the Milan superconducting cyclotron project.** Acerbi, E. (Univ. of Milan and Istituto Nazionale di Fisica Nucleare, Milan). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2126-2128(Aug 1983).

This paper presents an updated status report on the Superconducting Cyclotron, under construction at the University of Milan during the past two years, with funding chiefly provided by the Italian National Institute for Nuclear Physics. The cyclotron is designed for a K of 800 and a K /SUB FOC/ of 200 and thus yields maximum energies of 100 MeV/n for fully stripped light ions and 20 MeV/n for uranium and other heavy ions. The pole radius is 90 cm with three sectors having an average spiral constant of 1/45.7 rad/cm. The average magnetic field will span between 22 and 48 K Gauss with a corresponding R.F. frequency range between 15 and 48 MHz. The anticipated peak dee voltage is 100 KV with harmonic operation from h = 1 to h = 4. The operating modes include the use of an internal PIG source, injection from a 16 MV tandem, and axial injection from an external ion source. This paper presents the design parameters and outlines the progress made so far.

5170 **The JINR phasotron: status and progress.** Dzhelepov, V.P.; Dmitrievsky, V.P.; Onishchenko. (Joint Inst. for Nuclear Research, Dubna). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2134-2137(Aug 1983).

The synchrocyclotron of the Laboratory of Nuclear Problems for 680 MeV protons with a beam intensity of 2.3 mA and beam extraction efficiency of 5-7%, operational now for 30 years, has been under conversion since 1979. The conversion is aimed at making a phasotron with spatial variation of the magnetic field using the building and the magnetic core of the former accelerator. This spatial variation ensures vertical focusing of accelerated particles in the magnetic field growing along the radius and thus enables a reduction in the frequency range of the accelerating voltage which, in turn, results in a circa three-fold increase in the accelerating voltage and the cycle repetition. The conversion includes replacement of the electromagnetic windings, pole tips, accelerator chamber, dee with the resonance line, rotating capacitor, R.F. generator, ion source, beam extraction system, and auxiliary equipment. A computerized control system, based on microprocessors, will also be implemented. This paper reports the status of the conversion to date.

5171 **New heavy ion accelerators.** Lapostolle, P. (Ganil BP 5027 14021 CAEN Cedex). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1957-1961(Aug 1983).

Several new or upgraded versions of heavy ion accelerators have recently come into service. A review is made of these machines and tentative conclusions are drawn on the merits of the various types.

5172 **Status of the energy saver.** Orr, J.R. (Fermi National Accelerator Lab., Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1967-1969(Aug 1983).

The one-TeV synchrotron which has been under construction at Fermilab is nearly complete and is now entering the commissioning phase. The assembly and testing of the ring of more than 1000 superconducting magnets with its associated cryogenic, vacuum, power, R.F., controls and safety systems has gone extremely well.

5173 **Status of KEK TRISTAN project.** Nishikawa, T.; Horikoshi, G. (KEK, Nat.'l Lab. for High Energy Physics, Oho-machi Tsukuba-gun, Ibaraki-ken, 305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1983-1987(Aug 1983).

Status of the KEK TRISTAN project, the Phase I of which has been approved since 1981, is reported with an emphasis on its accelerator design and construction. The design of the accelerator complex has mostly been fixed. Construction of accelerator enclosure and production of accelerator components are under way with a target day for the first e^+e^- collisions in 1986.

5174 **Relativistic uranium beams - the Bevalac experience.** Alonso, J. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1988-1992(Aug 1983). Contract AC03-76SF00098.

This paper addresses areas where relativistic heavy ion accelerators differ from proton facilities. Salient areas are: the specialized injectors for heavy ions; ion sources, structures for very low charge-to-mass ratio (q/A) ions, and stripper optimization; special requirements for the synchrotron ring; ultrahigh vacuum, flexible controls and instrumentation. These areas are discussed in the context of the Bevalac as well as an idea for a next-generation relativistic heavy ion accelerator.

5175 **Kaon factories.** Craddock, M.K. (Physics Dept., Univ. of British Columbia, and TRIUMF, Vancover, BC V6T 2A3). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1993-1997(Aug 1983).

Kaon factories would provide beams 100-1000 times more intense than those available from present accelerators in the 10-30 GeV range. More intense or cleaner secondary beams of kaons, antiprotons and neutrinos would be of particular interest for high precision experiments and studies of rare processes in both particle and nuclear physics, e.g. symmetry violations in K decay, neutrino scattering, meson and baryon spectroscopy, hypernuclei, exotic atoms, K^+ studies of nuclear density and resonance propagation in nuclei. The various accelerators proposed include both fast cycling synchrotrons providing 100 μA proton beams at 15 to 32 GeV and superconducting isochronous ring cyclotrons giving 100-400 μA at up to 15 GeV. This paper describes these designs and the various technical problems associated with them.

5176 **Magnet sector design for a 15-GeV superconducting cyclotron.** Botman, J.I.M.; Craddock, M.K.; Kost, C.J.; Richardson, J.R. (TRIUMF, 4004 Wesbrook Mall, Vancouver, BC V6T 2A3). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2007-2009(Aug 1983).

Pole shape designs are presented which maintain focused and isochronous orbits in the two stages of a superconducting ring cyclotron kaon factory (CANUCK). The first stage of 15 sectors takes a 100 μA proton beam extracted from TRIUMF to 3.5 GeV. The second stage of 42 sectors continues the acceleration to 15 GeV. The orbit properties have been determined using a median plane magnetic field computed from the current distribution in the coils, and in current sheets simulating the saturated steel. The design process and the effects of various factors, including softness of the edges, cross-section of the coils, and negative field gullies, is described.

5177 **The CERN PS complex as an antiproton source.** (CERN, Geneva). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2039-2041(Aug 1983).

Four years after the start of the pp project, the PS-complex has become an effective p source. The process of p accumulation and transfer is recalled and the "modes" in which the machines operate are described. The performance achieved has permitted extended physics runs in which considerable operational experience has been gained.

5178 **Initial operation of the MSU superconducting cyclotron.** Mallory, M.L. (Cyclotron Lab., Michigan State Univ., East Lansing, MI 48824). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2061-2064(Aug 1983).

On August 31, 1982, the first beam was extracted from the Michigan State University superconducting K500 cyclotron. Shortly thereafter, the first experiment was performed with a 35 MeV/n carbon beam. The known operating characteristics of the K500 cyclotron are reported. Some of the technological innovations of the machine are described. Progress on the next phase of the project, the K800, is discussed.

5179 **The Argonne tandem-linac accelerator system.** Bollinger, L.M. (Argonne Nat.'l Lab. 9700 S. Cass Ave., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2065-2069(Aug 1983). Contract W-31-109-ENG-38.

Design considerations and operational experience for the existing heavy-ion accelerator consisting of a tandem injecting into a superconducting linac are summarized, with emphasis on the general features of the system. This introduction provides the basis for a discussion of the objectives and design of ATLAS, a larger tandem-linac system being formed by expanding the existing superconducting linac.

5180 **S.A.R.A. - a low cost heavy ion accelerator for 10 to 40 MeV/A.** M Lieuvin, M. (I.N2.P3. Institut des Sciences Nucleaires, 53, avenue des Martyrs, 38026 Grenoble Ceden). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2072-2076(Aug 1983).

S.A.R.A. "Systeme Accelerateur Rhone-Alpes" is a two stage accelerator now running at the Grenoble Institut des Sciences Nucleaires (I.S.N.). It is a Heavy Ion Accelerator giving beams from Li to Ar at a maximum energy of 40 MeV/amu.

5181 **Progress towards higher intensities and improved beam stability at TRIUMF.** Schmor, P.W.; Baartman, R.; Carey, J.W.; Dohan, D.; Dutto, G.; Mackenzie, G.H. (TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2092-2094(Aug 1983).

The TRIUMF accelerator routinely delivers up to 120 μA of 500 MeV protons. For tests, 150 μA have been extracted in a cw mode, 225 μA equivalent in a 10% duty cycle pulsed mode. Longitudinal space-charge effects are observed at these higher currents. A lead target, used as a beam dump and thermal neutron source, is being upgraded to allow extracted currents up to 375 μA cw. The reliability and performance of the cyclotron has significantly increased as the result of several recent developments. Improvements to the main magnet power supply (18,000 A) have resulted in a magnetic field stability better than + or -0.8 ppm for periods of 2 h. The effect on beam phase, instability and separated turn operation is presented. A Lamb-shift polarized H^- source provides up to 300 nA extracted. An ECR proton source has been tested as a replacement for the duoplasmatron on the polarized source. A gain in current of order 5 is expected. To satisfy the long-term needs, work has begun on developing an intense optically pumped, polarized source with the aim of increasing the current by a factor of 100.

5182 **Conceptual design of a 1.1-GeV 500μA fast cycling proton synchrotron.** Cho, Y.; Crosbie, E.; Khoe, T.; Kustom, R.; Martin, R.; Norem, J.; Praeg, W.; Thompson, K.; Wustefeld, G. (Argonne Nat.'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2117-2119(Aug 1983).

A very high intensity proton synchrotron system which could be used for a pulsed spallation neutron source and as low energy neutrino and meson physics facility is designed. The synchrotron would accelerate 200 MeV protons to 1.1 GeV with a repetition rate of 50 pulses per sec. The number of protons per pulse is 6.3×10^{13}, resulting in an average proton current of 500 μA. In order to accomodate the high intensity, considerable attention was directed toward minimizing beam loss, controlling space charge forces, and eliminating beam instabilities. Special features of the conceptual design include H^- charge exchange injection, a guide field flat-bottom of 1.5 msec to facilitate low-loss injection and capture, a 15 msec acceleration period, and a 3.5 msec time for the reset of the guide field. A separated function lattice consists of normal cells, dispersion suppressor cells, and matching cells. It provides sufficient straight section length to accommodate a fairly long rf system. A low impedance rf system (cathode-follower) is considered in order to overcome strong beam loading effects in the cavities. Rapid bunch shaping is employed at the end of acceleration to produce pulses of 200 nsec duration for possible neutrino experi-

ments. The transverse acceptances used in the design are: ϵ /SUB H/ = 500 π mm mr and ϵ /SUB V/ = 300 π mm mr.

5183 **Remote handling and accelerators.** Wilson, M.T. (AT-DO, MS H811 Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2138-2141(Aug 1983).

The high-current levels of contemporary and proposed accelerator facilities induce radiation levels into components, requiring consideration be given to maintenance techniques that reduce personnel exposure. Typical components involved include beamstops, targets, collimators, windows, and instrumentation that intercepts the direct beam. Also included are beam extraction, injection, splitting, and kicking regions, as well as purposeful spill areas where beam tails are trimmed and neutral particles are deposited. Scattered beam and secondary particles activate components all along a beamline such as vacuum pipes, magnets, and shielding. Maintenance techniques vary from "hands-on" to TV-viewed operation using state-of-the art servomanipulators. Bottom- or side-entry casks are used with thimble-type target and diagnostic assemblies. Long-handled tools are operated from behind shadow shields. Swinging shield doors, unstacking block, and horizontally rolling shield roofs are all used to provide access. Common to all techniques is the need to make operations simple and to provide a means of seeing and reaching the area.

5184 **Conceptual magnet design for an iron-free colliding beam accelerator.** Taylor, C.; Meuser, R.B. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2042-2044(Aug 1983). Contract AC03-76SF00098.

Superconducting accelerator magnets usually have magnetic iron yokes to obtain maximum magnetic fields and to limit stray fields. However, the iron is expensive and heavy. The smaller size and weight of an iron-free magnet can result in lower magnet and refrigeration costs. However in a colliding beam accelerator the stray field from one ring produces aberrations in the field in the other. A way to eliminate this mutual interference is to surround each magnet with a coil that exactly cancels the field from the other ring magnet. This is expensive in terms of superconductor requirements. However the cancellation of the external dipole field component is unnecessary. Only a small amount of superconductor is required for cancellation of the higher-order field-aberration components. Parameters for the iron-free magnet concept are investigated, and a preliminary conceptual design for an accelerator is presented.

5185 **Lattice for a 1.1-GeV 500-μA fast cycling proton synchrotron.** Cho, Y. (Argonne Nat.'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2129-2130(Aug 1983).

A very high intensity proton synchrotron lattice has been designed for a spallation neutron source system. The synchrotron is to accelerate a beam of 6.25 x 10^{13} protons from 200 MeV to 1100 MeV in 15 msec. A detailed discussion on the synchrotron is described elsewhere[1]. The proposed lattice is in modular form of storage ring type consisting of normal cells, dispersion suppressor cells and matching and straight section cells. Due to the fast repetition rate, the maximum required energy gains per turn is approximately 100 KeV, and this in turn needs approximately 20 meters or more of straight sections for the acceleration cavities. Such spaces for the cavities are to be provided by the straight insertion section. The lattice proposed here consists of four sectors, and each sector is made up by three FODO normal cells, four dispersion suppressor cells, and four matching and straight section cells. The total of 44 cells with approximately 90°/cell phase advance would then make the natural tune of the machine to be near 11. However a working point consideration prefers ν /SUB x/ = 10.3 and ν /SUB y/ = 11.3.

5186 **A 35-MV tandem Van de Graaff - the Vivitron.** Letournel, M. (Centre de Recherches Nucleaires, 67037 Strasbourg-Cedex). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2713-2715(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The Strasbourg project is a 35 MV Van de Graaff tandem whose design incorporates some new features and ideas. All the electrical characteristics are very conservative, specially for the accelerating tube which is a standard one, but the philosophy and some rules to build such an accelerator are new.

5187 **IBEX foilless diode experiments.** Miller, R.B.; Adler, R.J.; Mazarakis, M.G.; Poukey, J.W. (Sandia National Laboratories, Albuquerque, NM 87106). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2722-2724(Aug 1983). (CONF-830311—). Contract AC04-76DP00789.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A new high voltage isolated Blumlein accelerator (IBEX) has been designed and constructed. A new accelerator pulse-forming-line (PFL) configuration produces an output voltage pulse equal to the PFL charge voltage for a matched load (as in a conventional Blumlein circuit); however, the prepulse level is negligible and both sides of the diode remain at electrostatic ground potential. With a matched planar diode load, IBEX has generated a 4 MeV, 100 kA electron beam. In the present stage of experimentation, a foilless diode load is being used to produce 3-4 MeV, 20-30 kA annular electron beams with an applied magnetic field strength of about 10 kG.

5188 **Injection orbits of the single spiral pole tips.** Marti, F.; Blosser, H.G.; Johnson, D.; Milton, B. (Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* No. 4, 2105-2107(Aug 1983).

The original design of the K800 cyclotron called for a pole tip geometry with a double spiral. After studying the feasibility of designing a stripping mechanism that would fit inside one of the dees, it was decided to use the simpler single spiral pole tips. This paper describes the calculations done to study the injection orbits.

5189 **Developments of the CRYEBIS generation at Orsay.** Arianer, J.; Goldstein, C.; Laurent, H.; Malard, M. (Institut de Physique Nucleaire, BP 91405 Orsay Cedex). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2737-2739(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

CRYEBIS 2 is completed. The project is described. Main features are: 50 keV- 3.5 A decelerated electron beam, 5 T- 1.6 m long superconducting solenoid at 2.3°K. The gun to reach 10^4 A.cm^{-2} has been tested, and SILFEC 3, a smaller scale model of CRYBIS 2, has been extensively used with a CW electron beam and joined cycles up to 6 kV-1 A. The deceleration of electrons is reliable (from 10 keV to 1.8 keV) and the production of atoms of metal species by means of a laser has been tested.

5190 **Design of a dedicated heavy-ion accelerator for radiotherapy.** Gough, R.; Alonso, J.; Elioff, T.; Fugitt, J.; Garren, A.; Grunder, H.A.; Lancaster, H.; Sah, R.; Sorensen, B.; Staples, J. (Lawrence Berkeley Lab., Univ. of Cal., Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3067-3069(Aug 1983). (CONF-830311—). Contract AC03-76SF00098.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A new heavy-ion accelerator facility for radio-therapy is being designed at the Lawrence Berkeley Laboratory. Performance requirements have been established. Ions from helium to argon can be accelerated to a maximum energy of 800 MeV/nucleon with intensities in the range 10^8-10^9 particles per second. The accelerator subsystems consist of a linac injector, a synchrotron and a beam delivery system. Specifications have been developed for many of the technical components, and some details of the technical design are presented.

5191 **Improvements on the HIBALL heavy-ion fusion driver.** Hofmann, I.; Beckert, K.; Bohne, D.; Jahnke, A.; Muller, R.W. (Max-Planck-Institut fur Plasmaphysik, 8046 Garching). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3070-3072(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Preliminary studies of accelerator scenarios suitable for the HIBALL Heavy Ion Fusion Reactor Study have shown that it is of interest to consider an RF linac beam current as high as possible in order to reduce the filling time of the storage rings to about 1 msec. It is shown here for singly charged Bi ions (10 GeV kinetic, 5 MJ total energy) that such a scenario helps to avoid growth of the resistive microwave mode and reduces the complexity of transverse stacking manipulations in the rings. This work indicates that it might be desirable for future studies to lower the linac current and thus the enormous instantaneous RF power consumption by finding ways to suppress microwave growth in order to stretch the storage ring filling time.

5192 **The advanced light source.** Sah, R.C. (ALS Design Group, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3100-3102(Aug 1983). (CONF-830311—). Contract AC03-76SF00098.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The Advanced Light Source (ALS) is a new synchrotron radiation source which has been proposed by Lawrence Berkeley Laboratory. The ALS will be a key component in a major new research facility, the National Center for Advanced Materials. The ALS will consist of an electron linear accelerator, a "booster" synchrotron, a 1.3-GeV electron storage ring, and a number of photon beam lines. Most or all photon beam lines will originate from wiggler and undulator magnets placed in the 12 long straight sections of the ALS. A very low electron beam emittance will provide photon beams of unsurpassed spectral brilliance from specially-designed undulators, and a high radiofrequency will produce very short pulse lengths.

5193 **The 500-MeV, 2 1/2% duty factor linear electron accelerator (MEA).** Bruinsma, P.J.T.; Kroes, F.B.; Kuijer, L.H.; Noomen, J.G.; Spelt, J.B.; Vogel, A.G.C. (Nat.'l Inst. for Nuclear- and High-Energy Phys., sec. K P.O. Box 4395, 1009 AJ Amsterdam). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3599-3601(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Although the intermediate energy electron accelerator in Amsterdam has not reached completely its design specifications, since early 1981 a fully grown scientific program has developed using beams with an energy ranging from 20 to 120 MeV in the 140 MeV substation (for radio-chemistry and low-energy electron scattering over 180°) and from 70 to 400 MeV in the high energy stations for electron scattering and physics with pion and muon beams. A brief description of the MIT-type accelerator and its performance will be given with emphasis on typical features of the machine. Some examples will be given of recently obtained scientific data from which can be derived that the quality of the beam is in full accordance with the high performance level of the scientific equipment, involving a complex beam transport system and a pair of spectrometers for high resolution ($1x10^{-4}$) work.

5194 **Assembly and installation of the 2-MeV FMIT accelerator.** Liska, D.; Michelotti, R. (AT-4, MS H821 Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3620-3632(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The front end of the 35-MeV Fusion Materials Irradiation Test (FMIT) Facility accelerator is being assembled and installed at Los Alamos. The machine ultimately will produce a 500-kW continuous duty beam at 5 Mev, although only the first 2-MeV will be installed this year. The 2-MeV system will include the most powerful radio frequency quadrupole (RFQ) in existence. The assembly and installation of the hardware are described, along with the unique problems arising from the large size and high power of the components involved.

5195 **Intense beam recirculation.** Siambis, J.G. (Lockheed Palo Alto Research Lab., 3251 Hanover St., Palo Alto, CA 94304). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3195-3197(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The concept of racetrack-modified betatron recirculator-accelerator is introduced in order to recirculate intense-current electron beams under the same accelerating cavities several times (< 10) before extraction. Design criteria are obtained and the parameter space of operation is given.

5196 **Intense ion ring acceleration in a flux compressing liner.** Faehl, R.J.; Gisler, G. (Los Alamos Nat.'l Lab., Advanced Concepts and Plasma Applications Group, Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3201-3203(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Circular accelerators based upon increasing magnetic flux comprise one of the oldest classes of machines, the Betatron being a prime example. The authors have found that intense, charged neutralized ion rings can be acclerated to interesting energies by imploding a conducting liner on the field/ring configuration. Because the ring radius is not fixed, the authors find that the energy scaling varies from linear in the field at low energies to square root scaling at relativistic energies. Simple modeling has confirmed many of the characteristics the authors have seen in 2 1/2-D fully electromagnetic particle simulations.

5197 **Self-trapping electron ring accelerators.** Gisler, G.; Faehl, R. (Los Alamos Nat.'l Lab., Advanced Concepts and Plasma Applications Group, Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3204-3205(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Simulations performed with a fluid MHD extension to the PIC plasma code CCUBE show that it is in principle possible to design liner-driven ring accelerators so that they generate their own trapping well. The liner elements are tapered in mass and respond in a predictable way to the driving acceleration. Currents arise as the liner moves through an imposed axial field, and if the liner shape is appropriate, a magnetic trapping well results. A cusp-injected electron ring is then introduced, trapped, and accelerated to high energies.

5198 **Laser beat-wave accelerator for ultra-high energies.** Tajima, T. (Dept. of Phys. and Inst. for Fusion Studies, Univ. of Texas, Austin, TX 78712). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3209-3211(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Parallel intense laser beams ω_0,k_0 and ω_1,k_1 shone on a plasma with frequency separation equal to the electron plasma frequency ω /SUB pe/ is capable of creating a coherent large longitudinal electric field E /SUB L/ = Y1 /SUP 1/2/ mc ω /SUB pe/ / e of the order of 1-10GeV/cm for plasma density $10^{18-20}cm^{-3}$ through the forward Raman scattering. A concept of applying this process to an ultra-high energy (100-1000 TeV range) accelerator is considered. Associated physics questions such as the laser beam propagation, self-trapping, filamentation, the longitudinal dephasing are discussed. As a method to overcome the longitudinal dephasing, the relativistic forward Brillouin scattering process is proposed,

where the frequency separation of two lasers is now ω /SUB pi/ with ω /SUB pi/ being the ion plasma frequency.

5199 **Conceptual design for a CW 1-GeV double-sided microtron.** Hayakawa, K.; Sato, K.; Tanaka, T.; Tsukada, K. (Atomic Energy Research Inst., Nihon Univ., Tokyo 101). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3224-3225(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The design study of a double-sided microtron is presented. An idea and the results of beam optics for the first turn orbit in sector magnets and quadrupole magnets are described.

5200 **Relativistic collective effect accelerator to reach ultrahigh energies.** Winterberg, F. (Desert Research Inst., Univ. of Nevada System, Reno, Nevada 89507). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3238-3240(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A collective circular particle accelerator is proposed, with the potential to reach ultrahigh particle energies, including large luminosities. In the accelerator an electron cloud is produced within a large toroidal magnetic solenoid by inductive charge injection through the action of a travelling magnetic wave running around the torus. At the same time, the travelling magnetic wave accelerates the electron cloud to relativistic energies. By continuous inductive charge injection the cloud can be relativistically densified and the thusly densified cloud becomes the source of ultrastrong electric and magnetic fields, many times stronger than is possible using only externally applied fields. These large fields can then be used to keep ions in a circular orbit, and an accelerator with a circumference of 10 km could accelerate protons up to 10^3 TeV with luminosities up to 10^{33} $cm^{-2}sec^{-1}$.

5201 **Nuclotron status report.** Baldin, A.M.; Averichev, S.A.; Beznogikh, Yu.D.; Doniagin, A.M.; Khodzhibagijan, G.G.; Makarov, L.G.; Mikhailov, A.I.; Mikhailov, V.A.; Shelaev, I.A.; Vasilishin, B.V. (Joint Institute for Nuclear Research, Dubna). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3247-3249(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

An accelerator of relativistic nuclei at an energy of 6 GeV/u is presented in outline. The parameters of the accelerator and the characteristics of superconducting magnets with iron-shape magnetic field employed in it are given.

5202 **Long-pulse induction acceleration of heavy ions.** Faltons, A.; Firth, M.; Keefe, D.; Rosenblum, S. (Lawrence Berkeley Lab., Univ. of California, Berkeley, California 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3669-3671(Aug 1983). (CONF-830311—). Contract AC03-76SF00098.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A long-pulse induction acceleration unit has been installed in the high-current Cs^+ beam line at LBL and has accelerated heavy ions. A maximum energy gain of 250 keV for 1.5 μs is possible. The unit comprises 12 independent modules which may be used to synthesize a variety of waveforms by varying the triggering times of the low voltage trigger generators.

5203 **The advanced test accelerator (ATA), a 50-MeV, 10KA induction line.** Reginato, L. (Lawrence Livermore Nat.'l Lab., P.O. Box 808/L526, Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2970-2974(Aug 1983). (CONF-830311—). Contract W-7405-ENG-48.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The ATA is an induction accelerator designed to produce 70 ns pulses of electrons at currents of 10 kA and energies in excess of 50 MeV. The accelerator is capable of operating at an average rate of 5 Hz or at 1 kHz for ten pulses. The parameters were chosen primarily to provide the experimental basis for advancing the understanding of electron beam propagation physics. The 85 m accelerator has been under construction for the past four years and has adopted mainly an improved version of the ETA technology to satisfy the required parameters. Initial operation of the facility and the energy conversion system from primary power to axial electric field is described; recent advances in magnetic switching which have been incorporated in the injector are also discussed.

5204 **Status report on the upgraded Unilac.** Angert, N. (GSI, Gesellschaft fur Schwerionenforschung mbH, D-6100 Darmstadt). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2980-2982(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

By adding two Alvarez tanks to the Unilac poststripper maximum energies can be achieved of 19 MeV/u for uranium, and more than 20 MeV/u for ions of medium mass ($A \leqq 150$) using a second stripper in front of the single-gap cavity resonators. The injector beam transport system was modified, too, resulting, together with ion source developments, in an increase of beam intensities of about one order of magnitude. Operating experience of the first year after the upgrading is reported.

5205 **First operation of proton induction linac.** Kawasaki, S.; Kubota, Y.; Miyahara, A.; Yamamoto, K. (Fac. of Science, Kanazawa Univ., Kanazawa 920). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3016-3018(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A prototype of proton induction linac was developed to study the beam dynamics and the operational characteristics in this type of the accelerator specifically in the case of the intense ion beam acceleration. The driver system is composed of three identical unit modules, each of which consists three toroidal cores made of laminated silicon-iron foil of 0.1 mm thick and the driving circuit linked with the cores. The accelerating field of 28 kV/module is obtained typically during a period of 2 - 3 μsec. A proton beam of about 200 mA is extracted directly with the field driven inductively by the first module and then accelerated with succeeding two units to give the particles of about 60 keV at the output of the modules. Preliminary results of the measurements of the beam characters are given with the design of the device.

5206 **Research on electron linear accelerators with traveling wave resonators (2).** Yuan-ling, Wang. (Dept. of Physics, Univ. of Nanjing, Nanjing). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3024-3026(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In the first paper, under beam loading conditions, the formula of the energy gain of the electron linac with the traveling wave resonator was given. In this paper, under beam loading conditions, the field multiplication factor M /SUB b/ is derived. Under test of the electron linac with the traveling wave resonator, unstable phenomena are described. Their causes are discussed. They have been overcome.

5207 **Operation experience of the Riken variable-frequency heavy-ion linac, RILAC.** Kase, M.; Odera, M. (Linac Lab., Inst. Phys. and Chem. Research 2-1, Hirosawa, Wakoshi, Saitama, 351). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3033-3035(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The RILAC, the variable-frequency heavy-ion linac, which will be used as an injector to the separated sector cyclotron, has

provided useful beams to experimental groups. The frequency range available now is 18 - 30 MHz. The upper limit is determined by the parasitics mode at 35 MHz in the rf system. The beam energy can be varied in a wide range by changing the beam phase without degrading the beam quality so much.

5208 **The Texas A & M coupled-cyclotron system.** Laune, B.; May, D.; Youngblood, D.H. (Cyclotron Instit., Texas A & M Univ., College Station, TX 77843). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **30**: No. 2, 1367-1370(Apr 1983).

A superconducting (SC) cyclotron of the Michigan State University design having K = 500 and K /SUB F/ = 160 is under construction at Texas A&M and will be used both alone and as a heavy-ion injector for the existing 224-cm cyclotron. The heavy-ion performance of the completed facility is compared with some other U.S. facilities. Good intensity beams of lighter ions (A<40) above sonic velocity will be available with beams above the Coulomb barrier available throughout the periodic table. Deuterons and alpha particles to 80 MeV/nucleon will be available from the SC cyclotron, while up to 55 Mev protons, up to 130 MeV ^{3}He ions and polarized protons, deuterons, and ^{3}He ions will remain available from the present cyclotron.

5209 **Reduction of ripple voltage in a dynamitron.** Langsdorf, A. Jr. (Argonne Natl. Lab., Argonne IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **30**: No. 2, 1453-1455(Apr 1983).

The authors determined that a precise neutralization of the RF ripple voltage on the high voltage terminal of a Dynamitron has previously been prevented by a nonnegligible phase shift of RF currents in the two halves of the approximately 100 kHz class C oscillator tank circuit, which is actually constructed of two slightly unequal high-Q coupled circuits because it has two ground points: the inescapable center-tap-ground in the capacitive legs and a center-tap-ground lead to the induction coil. The latter is needed to prevent damage by flashover transients; equivalent to its removal was the adjustment of the RF ground return current to a null by aid of a current transformer on this lead and the suitable adjustment of trimmer capacitances. While the phase shift was thus held to a null, the actual ripple amplitude on the hv terminal was minimized by adjusting additional trimmer capacitances installed in the terminal of the machine. The p/p 100 kHz ripple at 2 MV DC output was then reduced to about 50 V and the RMS resolution by (p,Y) resonance threshold data near 1 MV was about 250 V. The limit of the resolution has various causes including mechanical vibrations and unbalanced harmonics of the RF.

4302 Beam Dynamics, Field Calculations, And Ion Optics

REFER ALSO TO CITATION(S) 5119, 5185, 5196, 5199, 5247, 5249, 5310, 5333, 5334, 5335

5210 **(LBL—16019) Survey and alignment for a 20-TeV on 20-TeV collider.** Close, E.R.; Douglas, D.R.; Sah, R.C. (Lawrence Berkeley Lab., CA (USA)). Aug 1983. Contract AC03-76SF00098. 7p. (CONF-830822—40). NTIS, PC A02/MF A01. Order Number DE84003042.

From 12. international conference on high energy accelerators; Batavia, IL, USA (11 Aug 1983).

The effects of magnet misalignments in a 20-TeV on 20-TeV anti pp collider are simulated numerically. Both short-range and long-range alignment errors are considered for an example lattice design, and closed-orbit errors are simulated. Finally, closed orbit corrections using a least-squares scheme are performed. Automatic surveying methods are attractive for a multi-TeV collider, because of the large accelerator circumference, the large number of magnets, and the small tunnel cross section. The specific example of an automatic surveying scheme based upon an Inertial Navigation System is discussed, and the most important sources of error are described.

5211 **Properties and possible use of beam-beam synchrotron radiation.** Bassetti, M.; Bosser, J.; Coisson, R.; Gygi-Hanney, M.; Hofmann, A.; Keil, E. (CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2182-2184(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In large electron-positron colliding beam facilities the fields created by one beam in the crossing point are quite large and cause the particles in the other beam to radiate synchrotron radiation. The total power emitted in the form of this beam-beam synchrotron radiation is calculated for beams with a bi-Gaussian cross-section colliding head-on, and its dependence on beam separation is estimated. The radiation emitted in the forward direction is quite hard and has a complicated spectrum. However the radiation emitted at angles much larger than both $1/\gamma$ and the deflecting angle, is softer and has the properties of "short magnet" radiation. Its spectrum observed at a fixed angle is directly given by the Fourier transform of the longitudinal dependence of the deflecting field, i.e. of the longitudinal distribution of the particles in the other beam. The polarization has a simple azimuthal dependence. This radiation can be used for beam diagnostics, i.e. centering the two beams suffering a natural separation, optimizing the luminosity, measuring the bunch length.

5212 **High power integral rf linac cavities.** Mitrovich, D.; Cooper, R.; Felber, F.; Wilson, P. (Western Research Corp., 8616 Commerce Ave., San Diego, CA 92121). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3518-3520(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Accelerating a long train of high current pulses requires a very large power flow from cavity to beam. Several advantages exist when this large rf power is supplied to the accelerating cavities at the same high rate at which the beam is extracting it. A particular approach to accomplishing this, the wake field transformer concept of Voss and Weiland, as applied to the parameter regime of interest is examined here. Several high current, low energy (few MeV) beams injected offaxis into the cavity are decelerated by their own and preceding fields. The resulting rf energy in the proper mode accelerates a lower current, high energy beam on-axis. Mode generation by an idealized annular beam is calculated as a function of driving current pulse width, cavity length, and radius of the annulus. Optimal pulse width is about half the wavelength of the TM_{010} accelerating mode, and the efficiency (the fraction of the energy going into the TM_{010} mode) is maximized for annulus radius equal to about two-thirds the cavity radius. The modest transformer ratio of about three (ratio of accelerating potential on-axis to decelerating potential on the driving beam) can be increased by making the annulus larger and sacrificing efficiency. Analysis of the beam dynamics shows that an axial magnetic field of the order of 1 kG is adequate to guide the annular power beam.

5213 **Parasitic modes removal out of operating mode neighbourhood in the DAW accelerating structure.** Andreev, V.G.; Belugin, V.M.; Esin, S.K.; Kravchuk, L.V.; Paramonov, V.V. (Inst. for Nuclear Research of the USSR Academy of Sciences, Moscow). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3575-3578(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The disk and washer (DAW) accelerating structure finds its use in a number of new projects (PIGMI, SNQ etc). It composes the main part of the accelerating structure of the meson factory now under construction in the Institute for Nuclear Research (INR), Moscow. It is known that the parasitic modes with azimuthal field variations exist at the operating mode region. In this report different methods of the parasitic modes frequency shift are considered. The main attention is given to the resonant methods, which are the most efficient.

5214 **Higher modes in the coupling cells of coaxial and annular-ring coupled linac structures.** Hoffswell, R.A.; Laszewski, R.M. (Dept. of Physics and Nuclear Physics Lab., Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3588-3589(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Dipole- and quadrupole-like modes in the coupling cells of coaxial and annular-ring coupled structures have been examined up to a frequency of 4 GHz. The quadrupole mode frequencies appear to lie high enough above the frequency of the accelerating mode to make coupling between the two unlikely. In the annular-ring case, however, a dipole mode was found very near the accelerating mode frequency. Evidence is presented which suggests that some power may couple between these two modes in a real cavity.

5215 **The NBS-LANL RTM end-magnet field mapper.** Lindstrom, E.R.; Debenham, P.H.; Mohr, D.L.; Yoder, N.R. (Nat.'l Bureau of Standards, Washington, DC 20234). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3605-3607(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A computer-controlled magnetic field mapper is under construction at the National Bureau of Standards to map the end magnets of the NBS-LANL racetrack microtron (RTM). The mapper consists of a large, two-dimensional translation stage which simultaneously positions a nuclear magnetic resonance (NMR) magnetometer probe in the 55 cm x 135 cm uniform field region and a temperature-compensated Hall effect probe in the fringe field region. A computer-based control system automatically positions the probes at points on a selected grid and records the measured field values and positions in computer memory. In this paper the authors describe the field mapping requirements, the mapper, its operation, and the field measurements and analysis that are to be performed.

5216 **A transverse-field-focussing (TFF) accelerator for intense ribbon beams.** Anderson, O.A.; Cooper, W.S.; Goldberg, D.A.; Soroka, L. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3215-3217(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In a TFF Accelerator, a transverse electric field is set up between pairs of curved deflecting plates. Charged particles passing between the plates are both deflected and strongly focussed by the field. Average-straight-line motion (if desired) is obtainable by having the successive pairs of plates curve in alternating directions (with corresponding reversal of the field). Acceleration is achieved by adjusting the mean voltage on each succeeding pair of plates. Computer simulations are in good agreement with the analytically calculated beam dynamics; they show no evidence of beam instabilities and almost no emittance growth. A design for a 400 keV, 8 A/meter, single-ribbon dc accelerator will be presented.

5217 **Transverse beam containment in the ANL 4-GeV microtron.** Colton, E. (Phys. Division, Argonne Nat.'l Lab., 9700 S. Cass Ave, Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3221-3223(Aug 1983). (CONF-830311—). Contract W-31-109-ENG-38.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Optical systems have been designed to contain the electrons during the acceleration from 0.1854.0 GeV. These systems are located in the dispersive straight sections and maintain a matched dispersion free beam with $\beta^* = 15.0$ m in the linac centers, and transverse beam waists in the centers of the dispersive straight sections. A thin-lens code has been developed to design the multi-energy system. Three versions of the focussing systems have been evolved: Two quadrupole triplets for E < 1.62 GeV; a single triplet for 1.655 < E 2.215 GeV, and a pentaquad system for E > 2.250 GeV. For the first case the authors step the exit edges for the 60° bending magnets so as to simulate a zero degree edge - this reduces vertical defocussing effects to an acceptable value. At the higher energies the exit edge angles are -60°. The entrance angles are 15° on the linac sides of the dipoles. Energy behavior of the Twiss parameters and quadrupole strengths are presented.

5218 **Analytical study of the generation and control of orbit errors in the ANL 4-GeV CW electron microtron design.** Kustom, R.L. (Physics Division, Argonne Nat.'l Lab., 9700 S. Cass Ave., Argonne IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3229-3231(Aug 1983). (CONF-830311—). Contract W-31-109-ENG-38.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The 4 GeV CW Electron Microtron (GEM) Design has 3 linac sections and 3 dispersive straight sections. Six 60° sector bending magnets separate the linac and dispersion straight sections. A magnetic optical system has been designed within the dispersive straight sections to contain the beam during the 36 or 37 return passes through the linacs. A major concern is the effect of small alignment or field errors on the equilibrium or desired orbit with a relatively strong focussing system. The results of an analytical study which shows the effect of small random errors on the orbit are presented. A study was also undertaken on the control of the orbit position by making error measurements in one dispersive section and making an angular adjustment with a small dipole in the preceding dispersive section. The analysis indicates that the orbit position can be adequately and easily controlled in the presence of random alignment and field errors.

5219 **Microwave measurements of azimuthal asymmetries in accelerating fields of disk-loaded waveguides.** Loew, G.A.; Defa, Wang; Deruyter, H. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3642-3644(Aug 1983). (CONF-830311—). Contract AC03-76SF00515.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

This paper presents microwave measurements of azymuthal asymmetries in the accelerating fields of the SLAC disk-loaded waveguide. These field asymmetries lead to RF phase-dependent beam steering which can be detrimental to operation of linear accelerators in general and of the SLAC Linear Collider in particular.

5220 **Evaluation and minimization of aberrations for a solenoid lens.** Armstrong, D.D.; Schneider, J.D. (AT-4 MS H821, Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2793-2794(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Relativistically correct computer simulations of transporting a beam of charged particles through a solenoid lens were used to study nonlinear focusing effects of this lens type. Input beams with both zero and nonzero emittance can be studied. The magnetic field is specified either by a Fourier-Bessel function-type expansion of the vector potential at a suitably chosen radius or by a direct interpolation of the fields calculated by the magnet design code POISSON. As an area in phase space, the dependence of nonlinear effects on field strength and beam radius was determined for a few magnetic field distributions. Attempts to tailor the field to minimize spherical aberrations are discussed.

5221 **The design of periodic beam transport systems.** Farrell, J.A. (AT-2 Ms H818, Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2804-2805(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Periodic beam-transport systems have several advantages including insensitivity to errors, minimum magnet apertures, and use

of standardized components. A simple procedure is given for the design of modules, with and without bending magnets, that have the same matched beam properties. These modules can be combined in certain ways to produce systems that are achromatic and require a minimum number of matching elements.

5222 **Design of the NSCL coupling line.** Harwood, L.H.; Blosser, H.G.; Nolen, J.A.; Resmini, R.F. (Cyclotron Lab., Michigan State Univ., East Lansing, MI 48824). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2806-2808(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The K500 and K800 cyclotrons at the National Superconducting Cyclotron Laboratory must be joined by a beamline which matches the emittance of the K500 to the acceptance of the K800. This paper describes the optical design of that beamline, with particular emphasis on the conceptual design process. Specific optical constraints are given along with the techniques used for meeting them. Beam diagnostics are also discussed. All magnets will be superconducting.

5223 **The beam bunching system for the Chalk River superconducting cyclotron.** Heighway, E.A.; Bigham, C.B.; McGregor, J.E. (Atomic Energy of Canada Limited, Research Company, Chalk River Nuclear Laboratories, Chalk River, Ontario, KOJ 1JO). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2809-2811(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The bunching system for the tandem accelerator-superconducting cyclotron is of the buncher-rebuncher type. It consists of a low energy gridded buncher before the tandem that produces a time focus at the tandem stripper, combined with a high energy buncher between the tandem and the cyclotron to correct for debunching of the beam produced by energy straggling in the stripper. To meet the cyclotron design energy resolution of $5{:}10^4$ the bunch length produced at the cyclotron has to be less than three degrees in rf phase.

5224 **High charge picosecond pulses with a double gap subharmonic buncher.** Mavrogenes, G.; Ficht, D.; Gallagher, W.; Kohe, T. (Argonne Nat'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2989-2991(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A new improved bunching system was designed in 1976 and installed in 1981 in the Argonne Electron Linac to replace the one installed in 1972. In the new bunching system, a spiral loaded double gap 12th subharmonic buncher is replacing the previous single gap 6th subharmonic buncher and a one wavelength fundamental frequency traveling wave prebuncher has replaced the previous two wavelength prebuncher. Individual pulses of picosecond (25 to 36) duration and up to 40 /eta/ Coulomb in charge, with $\Delta E/E \leqq +$ or 0.5% at FWHM over the energy range of 4 to 22 MeV, and a repetition rate from one to 1000 p psec are available to the experimenter on a routine basis. The design and the microwave properties of the cavity are discussed along with the general design of the injector and the results achieved.

5225 **The moment approach to charged particle beam dynamics.** Channell, P.J. (AT-6, MS H829, Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2607-2609(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The authors have derived the hierarchy of moment equations that describes the dynamics of charged particle beams in linear accelerators and can truncate the hierarchy at any level either by discarding higher moments or by a cumulant expansion discarding only correlation functions. They have also developed a procedure for relating the density expansion linearly to the moments to any order. The relation of space-charge fields to the density has been derived, and an accurate, systematic, and computationally convenient expansion of the resultant integrals has been developed.

5226 **Reduction of effective emittance by stacking beamlets in phase space.** Shubaly, M.R. (Atomic Energy of Canada Limited, Research Company, Chalk River Nuclear Laboratories, Chalk River, Ontario, KOJ 1JO). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2621-2623(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Multiple aperture extraction systems are commonly used to produce high current ion beams. One disadvantage of such systems is the dilution of the beam brightness by the grids. Typically, for the seven beamlets from a hexagonal array with a central aperture, the beamlets occupy only one-quarter of the area of the ellipse enclosing them. Beamlet steering by aperture displacement is commonly used in neutral beam injectors to reduce the size of the beam. For realistic beams, typical of high current-density extraction systems, beamlets can be stacked in phase space to reduce the effective emittance of the beam. This paper presents the concept of the technique and the experimental verification. In initial tests, the emittance of a 150 μA hydrogen beam from three in-line apertures was halved using the technique. The reduction was not from reduction in the source size as this decreased less than eight percent.

5227 **Magnetic field and beam dynamics calculations for SUSE.** Schott, W.; Hinderer, G.; Kienle, P.; Trinks, U.; Wilhelm, W.; Zech, E. (Physik-Department der Technischen Universitat Munchen, Munich). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2624-2626(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The SuSe magnet system is designed using the program GFUN3D. A small version of this program was connected to a general fit program by means of which the current in the main and trim coils was determined for a given isochronous mean field $B^-(r)$. For beam dynamics calculations with the code GOC accurate fields ($\Delta B^-/B^- <$ about 1%) were used which were obtained by means of the program GFUN400 where the unique part of the magnet iron is subdivided into 400 elements at maximum. Several coil systems have been investigated. In an alternative design all coils have straight sections which are easier to manufacture than coils with negative curvature. The main coils have a largest radial extension of 3.08 m. There are 22 correcting coils inside each main coil.

5228 **Vlasov theory of signal suppression for bunched beams interacting with a stochastic cooling feedback loop.** Chattopadhyay, S. (SPS Division, CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: vp(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The authors develop a self-consistent Vlasov theoretic description of the dynamic distortion of incoherent Schottky signals from a bunched beam undergoing stochastic cooling, arising from beam feedback. In the situation of non-overlapping synchrotron bands, explicit expressions for the signal suppression factors are derived and evaluated numerically for a prototype high-energy storage ring.

5229 **Theory of bunched beam stochastic cooling.** Chattopadhyay, S. (SPS Division, CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2649-2651(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A theoretical description of the time-evolution of a bunched beam subjected to stochastic cooling is provided.

5230 **Potential of a 3-dimensional halo charge distribution.** Takayama, K. (Fermi Nat.'l Accelerator Lab., P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2661-2662(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A simple method for obtaining the expression of the electrical potential for a 3-dimensional non-uniform charge distribution is given. It is shown how the method can be used to obtain the expression for a 3-dimensional halo distribution.

5231 **An optimization technique for computing chromatic corrections in heavy ion focussing systems.** Steinhoff, J.S. (Research Dept., Grumman Aerospace Corp., Bethpage, NY 11714). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2677-2679(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

An optimization algorithm is described for computing field strengths for a set of corrective sextupole magnets in a heavy ion focussing system. Initial results are presented which show that, in some cases, the beam transmission through a 1 mm pellet can be increased from an uncorrected value of about 60% to over 90%. The method should be useful for systems where, due to constraints or the presence of a number of abberations, no straight-forward theory exists for directly computing the field strengths.

5232 **Measurement of single bunch purity in the SRS.** Brown, G.S.; Jackson, A.; Mant, G. (Science & Engineering Research Council, Daresbury Laboratory, Daresbury, Warrington WA4 4AD). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2346-2347(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

During single bunch operation of the Daresbury SRS it is necessary to reduce the population of empty r.f. buckets to less than 1 part in 10^3. Measurement of the bunch intensity is by single photon counting using the synchrotron light emitted by the electrons. This technique is described; it is capable of resolving relative intensities of 1 part in 10^4 at the bunch spacing of 2 ns.

5233 **Measurement of bunch length with an image dissector tube.** Brown, G.S.; Suller, V.P.; Zinin, E. (SERC, Daresbury Lab., Daresbury, Warrington WA4 4AD). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2348-2350(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The length of the electron bunches in the SRS storage ring has been measured by focusing the synchrotron light onto an image dissector tube. The technique, which is applicable both to the single bunch mode and to the multibunch mode, is described. Bunch lengths of approximately 0.2 ns are measured with a resolution of 0.05 ns.

5234 **Automatic tuning of the LBL superhilac third injector transport line.** Pines, H. (Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2314-2316(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Testing of a new automatic tuning procedure in an LBL SuperHILAC beam transport line has been conducted with the third injector microcomputer control system. This technique is an advance over the sequential station-by-station automatic tuning method developed for the Bevalac transfer line. The computer now performs steering/focusing adjustments simultaneously on a number of quadrupole and dipole magnets comprising multiple-station sections of the injection line. New magnet currents are computed from equations governing beam optics in a real-time simulation of the beam line. The key to this technique is the calculation of beam transverse emittance utilizing the same control magnets and beam profile monitors used for manual tuning of the line. This emittance calculation requires high resolution beam profile measurements using multi-wire profile monitors recently installed in the third injector line.

5235 **A simple method for damping transverse motion of a high intensity electron beam.** Prono, D.S.; Caporasa, G.J.; Clark, J.C.; Lauer, E.J.; Struve, K.W. (Lawrence Livermore National Laboratory, Post Office Box 808/L-436, Livermore, California). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2510-2512(Aug 1983). (CONF-830311—). Contract W-7405-ENG-48.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The authors describe a simple electrostatic focusing method which efficiently damps transverse motion of a high intensity (both high current and high particle energy) electron beam. The principle is to create an electrostatic central force anharmonic potential field which phase mix damps transverse beam motion into increased beam emittance. The non-linear electrostatic field is created by a very resistive wire (L/R time about2 ns) strung axially down the accelerator vacuum pipe. Positive image charge equal to about1/2 the negative beam charge is induced onto the wire. Since the beam self fields cancel to within $1/Y^2$, the resultant wire electric field dominates. Experimental results showing the guiding, focusing and damping of transverse motion will be presented.

5236 **Analytic and numerical studies of the modified betatron.** Hughes, T.P.; Campbell, M.M.; Godfrey, B.B. (Mission Research Corp., 1720 Randolph Rd S.E., Albuquerque, NM 87106). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2528-2530(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The modified betatron concept has been proposed as a means of accelerating high current (kiloamp) electron beams to high energy. This device employs a toroidal magnetic field to overcome the space-charge limit on the current in a conventional betatron at low energy. In this paper, the authors look at the injection, equilibrium and stability of the modified betatron. The main emphasis is on stability. An analytic dispersion relation is derived using a cold-fluid model of the beam. The results are compared to three-dimensional simulations performed with the electromagnetic PIC code IVORY. The nonlinear development of the negative mass instability is followed in the simulations.

5237 **Beam breakup instabilities in high current electron beam racetrack induction accelerators.** Godfrey, B.B.; Hughes, T.P. (Mission Research Corp., 1720 Randolph Rd. S.E., Albuquerque, NM 87106). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* NS-30: No. 4, 2531-2533(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Beam breakup and negative mass instability growth rates for a 1 kA, 40 MeV electron beam racetrack induction accelerator are computed. The device is taken to have four acceleration gaps, each with 0.2 MeV applied voltage and 15 ohm transverse impedence; the guide field is 2 kg. The authors find that the total amplification of the beam breakup mode is limited to five e-foldings provided that the cavity mode quality factor Q is 6. Thus, the negative mass instability, which grows several times faster, is the dominant consideration. However, they also find that the energy range over which the negative mass instability occurs can be narrowed substantially by reducing the guide field strength after the beam has been accelerated to about 12 MeV. This approach, coupled with beam thermal effects, probably is sufficient to limit negative mass growth to acceptable levels in the racetrack accelerator.

5238 A probability function to fit radial distributions in PARMILA simulation beams. Boicourt, G.P. (AT-6, MS H829, Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2534-2536(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Proton or deuteron beams in linear accelerators have halos much too large to be described by the normal distribution. When the beam core is fitted to a normal distribution, the actual amount of beam past a given number of standard deviations is orders of magnitude above the normal distribution prediction. Knowing the distribution obeyed by beams would be helpful in evaluating beam spill using computer codes. Toward this end, a probability distribution has been found that fits PARMILA-generated radial beam distributions. The fitting distribution is a mixture of two generalized gamma (gg) distributions and fits both the beam core and the tail reasonably well. Its predictions in the halo region are substantially larger than normal distribution predictions. The distribution is described, examples of fits are given, and the ability to fit the tail is discussed.

5239 Optimized system for D^- production from charge exchange in alkali metals. Hooper, E.B.; Anderson, O.A.; Poulsen, P. (University of California, Lawrence Berkeley Laboratory, P.O. Box 808, Berkeley, California 94720). *Nuclear Technology/Fusion;* **2**: No. 3, 362-371(Jul 1982).

Negative ion production for neutral (deuteron) beam injectors is considered for a general system utilizing charge-exchange production in alkali metals. Experimental results provide parameters and show good correlation with calculations using known atomic cross sections, so that beam behavior can be predicted. It is found that coupling into the high voltage accelerator poses significant constraints on optimization of the system, e.g., to determine its minimum size. A typical design for 200-keV final energy provides D^- at 1.5 keV from charge-exchange in rubidium, with an average current density of 23 mA/cm^2 and a total current of 20 A.

4303 Auxiliaries And Components

REFER ALSO TO CITATION(S) 5115, 5213, 5219, 5231, 5493, 5610

5240 (CONF-830311—191) Brighter H^- source for the intense pulsed neutron source accelerator system. Stipp, V.; DeWitt, A.; Madsen, J. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE84003608.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Further increases in the beam intensity of the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory required the replacement of the H^- source with a higher current source. A magnetron ion source of Fermi National Accelerator Laboratory (FNAL) design was adapted with a grooved cathode to provide a stable 40 to 50 mA of beam operating at 30 Hz for up to a 90 μs pulse duration. Problems of space charge blowup due to the lack of neutralization of the H^- beam were solved by injecting additional gs into the 20 keV transport system. The source has recently been installed in the machine and the available input to the accelerator has more than doubled.

5241 (CONF-830311—192) Performance of the intense pulsed neutron source accelerator system. Potts, C.; Brumwell, F.; Rauchas, A.; Stipp, V.; Volk, G. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE84003607.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Portions are illegible in microfiche products.

The Intense Pulsed Neutron Source (IPNS) facility has now been operating in a routine way for outside users since November 1, 1981. From that date through December of 1982, the accelerator system was scheduled for neutron science for 4500 hours. During this time the accelerator achieved its short-term goals by delivering about 380,000,000 pulses of beam totaling over 6×10^{20} protons. The changes in equipment and operating practices that evolved during this period of intense running are described. The intensity related instability threshold was increased by a factor of two and the accelerator beam current has been ion source limited. Plans to increase the accelerator intensity are also described. Initial operating results with a new H^- ion source are discussed.

5242 (CONF-830910—7) Focusing optics for a synchrotron x radiation microprobe. Ice, G.E.; Sparks, C.J. Jr. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01. Order Number DE84003286.

From 3. national conference on synchrotron radiation instrumentation; Upton, NY, USA (12 Sep 1983).

We propose two constant deviation and energy-tunable fluorescent microprobe optical designs which efficiently use x rays available from ending magnets and insertion devices of synchrotron radiation sources. The simpler system consists of a cylindrically bent multilayer to focus the vertical opening angle by in-plane scattering, a fixed radius cylindrically curved multilayer which sagittally focuses the horizontal divergence, and a pinhole to further reduce the beam to microprobe dimensions. A more versatile system has a pair of flat nondispersively arranged diffracting optics followed by crossed elliptical mirrors. These nondispersive combinations can produce a fixed-exit beam. We compare the relative intensity with other optical systems.

5243 (CONF-831180—4) Normalized emittance of SITEX negative ion source. Stirling, W.L.; Dagenhart, W.K.; Whealton, J.H.; Donaghy, J.J. (Oak Ridge National Lab., TN (USA); Washington and Lee Univ., Lexington, VA (USA)). 1983. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01. Order Number DE84003285.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

An emittance measurement employing two techniques are being made on SITEX. To this end, a 2-D calculation was performed to design the accelerator in order to reduce electric field abberations. The calculated normalized emittance is 6×10^{-4} IIcm mrad for an angular divergence θ/sub RMS/ $\approx 0.28°$. Status of the experimental findings are presented and a comparison made to the calculated value which will yield the ion sputter energy.

5244 (CONF-8309156—8) Intense pulsed neutron source accelerator status. Potts, C.W.; Brumwell, F.R.; Stipp, V.F. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE84003576.

From 7. meeting of the international collaboration on advanced neutron sources; Ontario, Canada (12 Sep 1983).

The Intense Pulsed Neutron Source (IPNS) facility has been in operation since November 1, 1981. From that date through August 1, 1983, the accelerator system was scheduled for 7191 hours of operation. During this period, 627 million pulses totaling about 1.1×10^{21} protons were delivered to the spallation target. The accelerator has exceeded goals set in 1981 by averaging 8.65 μA over this two year period. This average beam current, while modest by the standards of proposed machines, makes the IPNS synchrotron (Rapid Cycling Synchrotron [RCS]) the highest intensity proton synchrotron in the world today. Detailed data on accelerator operation are presented. Weekly average currents of 12 μA have been achieved along with peaks of 13.9 μA. A great deal has been learned about the required operating constraints during high beam current operation. It should be possible to increase the average beam current during this next year to 12 μA while observing these restraints. Improvement plans have been formulated to increase the beam current to 16 μA over the next three years.

5245 (CONF-8309156—11) IPNS accelerator system and neutron chopper synchronization. Rauchas, A.; Ostrowski, G.; Pelizzari, C.; Volk, G. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE84003613.

From 7. meeting of the international collaboration on advanced neutron sources; Ontario, Canada (12 Sep 1983).

Several of the neutron scattering instruments at the Intense Pulsed Neutron Source (IPNS) at Argonne use neutron choppers for monochromatization of the neutron beam. Since the neutron burst is produced by a proton beam extracted from the Rapid Cycling Synchrotron (RCS), precise synchronization must be maintained between the RCS and the chopper aperture to minimize the degradation of energy resolution. The first attempts at synchronization were made in 1978 on the ZING-P' facility with a single chopper. Synchronization was further complicated after IPNS began operating in 1981 when a total of three chopper experiments came online. The system in use during that period of time was able to maintain synchronization with typical data collection efficiencies ranging from 20 to 70%. A synchronization system improvement, installed in late 1982, increased the data collection efficiencies of all the IPNS chopper systems to 99+%. The development of the RCS and neutron chopper synchronization system is described together with a detailed description of the present system.

5246 **(LA-UR—83-3444) Particle accelerator control and data acquisition in the context of VAX/VMS.** Schaller, S.C.; Corley, J.K. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 6p. (CONF-8310182—9). NTIS, PC A02/MF A01. Order Number DE84003817.

From US fall DECUS symposium; Las Vegas, NV, USA (24 Oct 1983).

The Los Alamos Meson Physics Facility (LAMPF) Control System monitors and controls a linear accelerator through more than 10,000 widely disparate I/O devices. The heart of the Control System software is the Data System, which provides a uniform application program interface based on symbolic device names. In many ways the Data System parallels the VAX/VMS Record Management Services (RMS) in its needs for asynchronous operations, protection, and locks for multiprocess interactions. Since the accelerator control hardware is continually changing, it is important that privileged code be kept to a minimum or be testable in a non-privileged environment. This paper describes the LAMPF Data System design including the use of VAX/VMS user written system services (both kernel and supervisor mode), a user supplied image rundown routine, the VAX/VMS lock manager, and a large (3.5 Mbyte) protected global section.

5247 **(LBL—16498) Chromatic properties and tracking studies of a 20 TeV pp collider.** Garren, A.; Cornacchia, M.; Dell, F. (Lawrence Berkeley Lab., CA (USA); Brookhaven National Lab., Upton, NY (USA)). Aug 1983. Contract AC03-76SF00098. 7p. (CONF-830822—41). NTIS, PC A02/MF A01. Order Number DE84002917.

From 12. international conference on high energy accelerators; Batavia, IL, USA (11 Aug 1983).

The chromatic properties of a lattice for the 20 TeV pp collider described in an accompanying paper have been investigated. Since this machine has a low β-function value at the interaction points (β/sub x,y/ = 2 m), the large value in the nearby quadrupoles is a major source of perturbations for off-momentum particles. Preliminary tracking studies have been performed in an attempt to determine the dynamic aperture. The model includes the effects of chromaticity sextupoles, octupoles to straighten the working line, random multipoles simulating magnet construction errors and closed orbit distortions.

5248 **(LBL—16554) Thermal problems on high flux beam lines.** Avery, R.T. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 44p. (CONF-830910—6). NTIS, PC A03/MF A01. Order Number DE84003044.

From 3. national conference on synchrotron radiation instrumentation; Upton, NY, USA (12 Sep 1983).

Wiggler and undulator magnets can provide very intense photon flux densities to beam line components. This paper addresses some thermal/materials consequences due to such impingement. The LBL/Exxon/SSRL hybrid-wiggler Beam Line VI now nearing operation will be able to provide up to ~ 7 kW of total photon power at planned SPEAR operating conditions. The first masks are located at 6.5 meters from the source and may receive a peak power density (transverse to the beam) exceeding 20 kW/cm^2. Significantly, this heat transfer rate exceeds that radiated from the sun's surface (7 kW/cm^2) and is comparable to that of welding torches. Clearing, cooling and configuration are of critical importance. Configurations for the first fixed mask, the movable mask, and the pivot mask on this beam line are presented together with considerations of thermal stress fatigue and of heat transfer by conduction to water-cooling circuits. Some preliminary information on heating of crystals and mirrors is also presented.

5249 **(SAND—83-1780) Electron motion in fast magnetically insulated ion probes.** Lockner, T.R.; Poukey, J.W. (Sandia National Labs., Albuquerque, NM (USA)). Nov 1983. Contract AC04-76DP00789. 13p. NTIS, PC A02/MF A01. Order Number DE84003330.

Simulations have been performed to determine the time-dependent response of an intense ion beam incident on a transverse magnetic field. The geometry is appropriate for the simulation of a magnetically insulated ion probe. For a case with parameters such that the beam electrons should be stripped from the ions, the electrons nevertheless drift with the beam at a reduced velocity. The operation of the probe is thus inhibited after an electron transit time to the collector.

5250 **ASPUN, design for an Argonne super intense pulsed neutron source.** Khoe, T.K.; Kustom, R.L. (Physics Div., Argonne Nat.'l Lab., 9700 S. Cass Ave., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2086-2088(Aug 1983). Contract W-31-109-ENG-38.

Argonne pioneered the pulsed spallation neutron source with the ZING-P and IPNS-I concepts. IPNS-I is now a reliable and actively used source for pulsed spallation neutrons. The accelerator is a 500 MeV, 8-9 μa, 30 Hz rapid cycling proton synchrotron. Other neutron spallation sources are now in operation or in construction. These include KENS-I at the National Laboratory for High Energy Physics in Japan, the WNR/PSR at Los Alamos National Laboratory, and the SNS at the Rutherford Appleton Laboratory in England. Newer and bolder concepts being developed for more intense pulsed spallation neutron sources include SNQ at the KFA Laboratory in Germany, ASTOR at the Swiss Institute for Nuclear Physics, and ASPUN, the Argonne concept. ASPUN, presented in this paper, is based on the Fixed-Field Alternating Gradient concept. The design goal is to provide a time-averaged beam of 3.5 ma at 1100 MeV on a spallation target in intense bursts, 100-200 nanoseconds long, at a repetition rate of no more than 60 to 85 Hz. Design parameters are given.

5251 **A 100-MeV injector race-track microtron for the max storage-ring/pulse-stretcher.** Eriksson, M. (MAX-LAB, Univ. of Lund, S-223 63 Lund). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2070-2071(Aug 1983).

A 100 MeV pulsed race-track microtron (RTM) has been in operation at the University of Lund since 1979[1]. The RTM will now be used as an injector for a storage-ring/pulse-stretcher currently being built. The RTM with its injection, acceleration and extraction systems are described and the beam characteristics are discussed.

5252 **ASTOR, concept of a combined acceleration and storage ring for the production of intense pulsed or continuous beams of neutrinos, pions, muons, kaons and neutrons.** Joho, W. (Swiss Institute for Nuclear Research, CH 5234 Villigen). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2083-2085(Aug 1983).

A new concept for a high intensity accelerator for 2 GeV protons using the continuous 590 MeV beam from the present ring cyclotron has been worked out at SIN. To suppress the cosmic background in neutrino experiments a pulsed beam with high peak current and low duty cycle is required. Using the so called phase expansion effect 1,2 one can combine the acceleration and storage effect in a single isochronous cyclotron ASTOR. With the help of several RF cavities, positioned at different radii, it is possible to operate ASTOR either in a pulsed mode at 1500 Hz or in a continuous mode. The anticipated beam powers are .8 MW and 4 MW respectively. The ASTOR concept is also applicable in a possible

kaon factory design, acting as an interface between the SIN ring cyclotron and a 50 Hz synchrotron for 15 to 20 GeV protons.

5253 **Upgrading the Heidelberg MP-Tandem postaccelerator combination.** Grieser, M.; Hammel, R.; Huck, B.; Ingwersen, H.; Jaeschke, E.; Repnow, R. (Max-Planck-Institut fur Kernphysik, Postfach 103980, D-6900, Heidelberg). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2095-2098(Aug 1983).

The Heidelberg Tandem Postaccelerator Combination is undergoing a stepwise upgrading program intended to considerably extend its mass and energy range as well as to increase the available intensity of heavy ion beams. In a first step in 1982 a resonator module of four newly developed $\beta = 0.12$ spiral-splitring resonators had been added to the high energy end of the linear accelerator. These resonators deliver rf-voltages of 0.5 MV (CW) and 1.0 MV (df = 0.25) each, increasing the effective acceleration voltage of the booster to 22.5 MV. To improve the performance of the accelerator system for the heaviest projectiles, two extensions are under construction. A 3 MV negative ion injector based on a reconstructed single ended pelletron accelerator is nearing completion. It is designed to facilitate the injection of well isotope separated low emittance beams of the highest masses into the low acceptance acceleration tubes of the MP-Tandem, thus reducing beam loading and allowing for considerably higher intensities of beams like ^{197}Au, ^{208}Pb, and ^{238}U. Later on a module of four $\beta = 0.04$-spiral-splitring resonators will be installed in front of the linac to match the velocity of heavy ions like ^{238}U to the presently operating machine.

5254 **Deceleration of highly stripped ions by the Heidelberg RF-postaccelerator.** Grieser, M.; Hammel, R.; Huck, B.; Ingwersen, H.; Jaeschke, E.; Kolb, B.; Repnow, R. (Max-Planck-Institut fur Kernphysik, P.O. Box 103980, D-6900 Heidelberg). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2099-2101(Aug 1983).

The Heidelberg MP-tandem has been used to produce highly stripped ions of S 14,15,16+, Ni 20+ and Br^{23+} which subsequently were decelerated by the normal conducting rf-postaccelerator. The minimum energy obtained so far in the deceleration mode is 0.15 MeV/amu for S^{15}. Although the beam transmission is decreasing with decreasing final energy because of a longitudinal and transverse emittance growth, decelerated beams have been routinely used for atomic physics experiments.

5255 **Design status of the Munich cyclotron SUSE.** Trinks, U.; Daniel, H.; Graw, G.; Hinderer, G.; Huenges, E.; Kienle, P.; Korner, H.J.; Morinaga, H.; Nolden, F.; Nolte, E. (Physik-Department der Technischen Universitat Munchen and Sektion Physik der Universitat Munchen, 8046 Garching,). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2108-2110(Aug 1983).

At the Munich Accelerator Laboratory the design study for the superconducting sector cyclotron SuSe with the existing 13MV-tandem as the injector is in a final state. SuSe will accelerate protons and heavy ions to maximum energies of 500MeV and respectively 300MeV/u (for Q/A=0.5) with excellent beam properties. Some new technical developments were needed. A prototype of a superconducting sector coil is under test. Several models for the RF-cavities were built. At present a 1:1 prototype power model is under construction. A superconducting channel magnet without stray fields for injection is developed.

5256 **Injection from the K500 superconducting cyclotron into the 88″ cyclotron at Texas A & M.** Laune, B.; Chapman, W.C.; Derrig, G.; May, D.P.; Rogers, R.C.; Smelser, P.; Tsien, Y.L.; Walterscheid, W.J.; Youngblood, D.H. (Cyclotron Inst., Texas A & M Univ., College Station, Texas). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2111-2113(Aug 1983).

The construction of a superconducting cyclotron of the MSU design (K=500, K /SUB f/ =160) is under way at Texas A&M. It will be used both alone and as an injector for the existing 88″ (K147) cyclotron. A beam optics study has been carried out for injection of K500 cyclotron heavy-ion beams into the K147 cyclotron. This study traces a variety of beams from extraction at the K500 cyclotron until focused and dispersion matched into the proper orbit of the K147 cyclotron. The line is configured to decouple the parameters of each cyclotron by first bringing the momentum dispersion to zero and then producing a double waist which serves as the apparent source for the second cyclotron. Beam line optics for "stand alone" operation of the K500 cyclotron, which provides for use of the present experimental facilities, have also been studied. Construction of the K500 cyclotron is proceeding approximately on schedule with operation expected in 1985.

5257 **Performance of the intense pulsed neutron source accelerator system.** Potts, C.; Brumwell, F.; Rauchas, A.; Stipp, V.; Volk, G. (Argonne Nat.'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2131-2134(Aug 1983).

The Intense Pulsed Neutron Source (IPNS) facility has now been operating in a routine way for outside users since November 1, 1981. From that date through December of 1982, the accelerator system was scheduled for neutron science for 4500 hours. During this time the accelerator achieved its short-term goals by delivering about 380,000,000 pulses of beam totaling over 6×10^{20} protons. The changes in equipment and operating practices that evolved during this period of intense running are described. The intensity related instability threshold was increased by a factor of two and the accelerator beam current has been ion source limited. Plans to increase the accelerator intensity are also described. Initial operating results with a new HL^- ion source are discussed.

5258 **Research efforts on increase of IHEP protron synchrotron intensity.** Ado, Yu.M.; Myae, E.A.; Naumov, A.A.; Teplyakov, V.A.; Troyanov, E.F. (Institute for High Energy Physics, Serpukhov). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2053-2055(Aug 1983).

The intensity of 5.6×10^{12} ppp attained at the IHEP accelerator with a proton injection energy of 100 MeV is close to the incoherent Coulomb limit. The construction of a new 1.5 GeV injection system (fast cycling booster) to increase the accelerated beam intensity is near completion. A number of the main ring systems have been modified with the goal to get ready for the booster operation.

5259 **Status report on GANIL.** (GANIL BP 5027 14021 CAEN Cedex, Tel. (31) 94 81 11 Telex 170533 F). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2102-2104(Aug 1983).

The first beam (Ar^{+4}) from SSC1 was obtained in June 82. A full energy Ar^{+16} beam at about 44 MeV/A was accelerated in SSC2 in November and delivered to physicists in January 83. Till now, nine experiments have been performed.

5260 **DESY II, a new injector for the DESY storage rings PETRA and DORIS II.** Hemmie, G. (Deutsches Elektronen-Synchrotron DESY, Notkestrasse 85, D-2000 Hamburg 52, W. Germany). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2028-2030(Aug 1983).

There is a proposal to build a new 9 GeV electron synchrotron as a dedicated injector for the storage rings DORIS and PETRA. This machine will be housed in the old DESY-tunnel side-by-side with the original DESY-synchrotron. It is characterized by a separated function lattice, a 12.5 Hz repetition frequency, an all-metal vacuum chamber and a high shunt impedance rf-system. After commissioning of this new machine in 1984, the old DESY-synchrotron could be converted into a dedicated proton-accelerator as part of the injection chain for HERA.

5261 **Polarized ^{3}he ion source based on the 2^3S_1 metastable state.** Slobodrian, R.J.; Gagnon, Y.; Giroux, J.; Labrie, R.; Lapointe, R.; Pouliot, L. (Universite Laval, Department de Physique, Laboratoire de Physique Nucleaire, Quebec G1K 7P4). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2731-2733(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

This ^{3}He polarized ion source is based on the 2^3S_1 metastable atomic state. It will produce an intense metastable beam, $6x10^{15}p.sec^{-1}.sr^{-1}$, of energies between 0.07 and 0.1 eV, using a cold cathode discharge. The separation and focussing of Zeeman components (F=½ m /SUB F/ =½) and (F=3/2m /SUB F/ =3/2) is effected with a sextupole of variable gap. An adiabatic RF transition enhances the nuclear polarization (theoretical) to 100%. Most design parameters of the source are now frozen for operation inside the H.V. terminal of a CN van de Graaff, but the source is of universal use in (+) ion accelerators.

5262 **Operational characteristics of a radial extraction ion source with an injected electron beam.** Abdelaziz, M.; Abdelbaki, M.; Zakhary, S. (Nuclear Research Cntr., Egyptian Atomic Energy Authority). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2699-2701(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

An RF ion source of the radial extraction type is modified by introducing an electron gun to supply electrons which interact radially with the source's plasma, thereby increasing ionization density. A tungsten filament is used with an accelerating electrode, under the influence of an axial magnetic field. Two plasma tubes have been tested with the same tube length (12 cms) and diameters 4&5 cms respectively. Glass-coated tungsten wires are immersed in the plasma as electrical probes. Two extraction electrodes of apertures 4 and 8 mm are used. The extraction characteristics indicate 15% increase in the extracted ion beam.

5263 **Status of the AGS polarized negative ion source.** Alessi, J.; Kponou, A.; Raymond, R.; Sluyters, Th. (Accelerator Department, Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2708-2709(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Development of an intense polarized H- source for the AGS continues at Brookhaven National Laboratory. Initial tests with about one milliampere, 40 keV pulsed neutral cesium beam, colliding with more than two milliampere polarized hydrogen atoms, produced about one-half microampere polarized negative ions, extracted at 20 keV. A new pulsed cesium source with an anticipated output of 5-15 mA and an improved neutralizer are under construction.

5264 **Operating experience with an ion source in a superconducting cyclotron.** Antaya, T.A.; Kuchar, J.A.; Mallory, M.L. (National Superconducting Cyclotron Lab., Michigan State Univ., East Lansing, MI 48824). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2716-2718(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The authors have developed a PIG ion source for axial insertion in the K500 cyclotron. The operation of the ion source has been limited to the requirements demanded by the operation of the cyclotron. These requirements have been for moderate charge state light heavy ions, of principally carbon, nitrogen and neon. The source design is more than adequate for moderate charge states with lifetimes of 8-12 hours for carbon and in excess of 15 hours for nitrogen and neon. The authors are now just starting to push the source to produce high charge states, and have not yet established whether this source design will be adequate.

5265 **External tandem target system for efficient production of short-lived positron emitting radionuclides.** Koh, K.; Dwyer, J.; Finn, R.; Sheh, Y.; Sinnreich, J.; Wooten, T. (Mt. Sinai Medical Cntr., Cyclotron Facility, Miami Beach, Florida 33140). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3064-3066(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Recent developments in radiopharmaceutical chemistry allow the incorporation of short-lived, positron-emitting radionuclides into a variety of compounds which when used with a positron emission tomograph provide a means of monitoring physiological disorders by a standard technique. To effectively meet the increased "in-house" clinical demands while maintaining a production schedule, a tandem target was designed and has been installed for the simultaneous "on-line" preparation of oxygen-15 labelled compounds such as CO_2^{15}, H_2O^{15}, and nitrogen-13 labelled compounds such as $^{13}NH_3$, $^{13}N_2O$, and $^{13}N_2$. The processing time required for the synthesis of the nitrogen-13 products as compared to the essentially instantaneous formation of oxygen-15 labelled compounds has provided the necessary time delay for clinical utilization. The characterisitcs of this external tandem target system as well as the automation for the dual processing are presented.

5266 **Determination of the rf leakage field in the vacuum tank of the TRIUMF cyclotron.** Hohback; Dohan, D.; Dutto, G.; Enegren, T.A.; Fong, K.; Pacak, V. (CERN, Geneva). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3514-3516(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In the TRIUMF cyclotron the dees are partially defined by the two halves of the quasi-circular vacuum chamber, which completely contains the 1 MW resonating cavity. A stray electric field or "RF leakage" exists inside the dees and has occasionally caused problems to probes or other tank equipment. In order to understand the nature of this field a precise 1:10 scale metal model of the entire tank and resonator system has been built and is being investigated. Various resonances have been identified: the push-pull mode at 226 MHz and the push-push mode at 233 MHz; cross modes along the dee gap resonate at 243 MHz and 253 MHz. In the quasicircular tank region outside of the main resonating cavity the Tm_{310} and Tm_{410} modes are mainly responsible for the configuration of the leakage field since they are closer to the operating frequency. The measurements are in reasonable agreement with the results of numerical relaxation calculation and with measurements in the cyclotron tank.

5267 **A four gap synchrotron rf cavity.** Smythe, W.R. (Nuclear Physics Lab., Univ. of Colorado, Boulder, CO 80309). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3517(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A proposed four gap synchrotron cavity is described here. The drift tube (140° long) is rigidly supported by a reentrant conducting structure near each end. Each support structure provides two accelerating gaps. The potential across each gap is approximately the same as the potential between the drift tube and the vacuum tank wall in the central region. The reentrant feature has the effect of a two-turn center tapped transformer, which is achieved in the cavity by passing one current surface through another by means of spokes and holes.

5268 **RFQ linac structure developments at CRNL.** Hutcheon, R.M.; Hansborough, L.D.; Hohban, K.J.; Schriber, S.O. (Atomic Energy of Canada Limited, Research Company, Chalk River Nuclear Laboratories, Chalk River, Ontario KOJ 1JO). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3521-3523(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Modeling studies of RFQs for a 300 mA cw proton accelerator are continuing at CRNL. Initially, low power models of the four-vane structure with standard end terminations were extensively investigated. Later, results of simple rf dipole experiments led to studies of two new RFQ termination schemes, the double dipole (in which two opposing vanes were shorted at both ends) and the folded dipole (in which one set of opposing vanes was shorted at one end, the other vane set shorted at the other end). Various end tuner configurations were also tested, including radial end tuners and Bourdon tube mechanisms for remote positioning. Finally, a versatile low power RFQ model has been built to study rf properties with reproducible vane geometry.

5269 **Integral radial stems on aluminium $\beta=1$ disk-and-washer structures.** Schriber, S.O. (Atomic Energy of Canada Limited, Research Company, Chalk River Nuclear Laboratories, Chalk River, Ontario, KOJ 1JO). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3539-3541(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Aluminum test cavities were manufactured with integral radial stems to support the washers of a $\beta=1$ 2500 MHz disk-and-washer structure. Difficulties in making stem joints were therefore eliminated. From one to four integral stems were studied. Measurements showed that four stem support was best and that two stems mounted at 180° to each other created rf problems. The frequencies of higher order mode passbands can be shifted to result in a structure with good rf efficiency, coupling and quality factor for the $\pi/2$ operating mode.

5270 **Disk-and-washer linac structure with biperiodic T supports.** Iwashita, Y. (AT-DO, MS 811 Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3542-3544(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The disk-and-washer (DAW) linac structure with particular biperiodic washer-support geometries promises to be an excellent structure for $\beta > 0.5$ accelerator applications. Outstanding features of this structure include high efficiency, high stability, good vacuum properties, and ease of fabrication.

5271 **Voltage breakdown in S-band linear accelerator cavities.** Tanabe, E. (Radiation Division, Varian Assoc. Inc., Palo Alto, CA 94303). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3551-3553(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Voltage breakdown is one of the major limiting factors in the design of a high accelerating gradient linear accelerator structure. A multiple-use cavity test system was developed to establish the criteria for voltage breakdown in S-band pulsed electron linear accelerator cavities, in terms of cavity geometry, accelerating gradient, RF pulse shape and repetition rate, surface finish, temperature and external magnetic field. The experimental set-up and test procedure, as well as the experimental results, are presented.

5272 **185-MeV injector design for the ANL 4-GeV microtron project.** Colton, E. (Physics Division, Argonne Nat.'l Lab., 9700 S. Cass Ave., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3232-3234(Aug 1983). (CONF-830311—). Contract W-31-109-ENG-38.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The injector starts with a 5 MeV preinjector followed by an 18 MeV S-band linac. The 23 MeV electrons are transported and injected into a Racetrack Microtron via a 10° achromatic bend system. Twenty-seven turns are used to boost the energy to 185 MeV. Reverse-field stripes on the 180° end magnets and quadrupole focussing on the return paths maintain a matched-dispersion free beam with transverse $\beta^* = 5.0$ m in the center of the 4.6 m long linac. The beam is recirculated outside of the RTM linac to shear the longitudinal phase-space ellipse before extraction. The extracted beam is transported and injected into the six-sided microtron at 185 MeV.

5273 **150-MeV pulse stretcher of Tohoku Univ.** Tamae, T.; Hirooka, M.; Kawazoe, Y.; Miyase, H.; Muto, M.; Shibazaki, Y.; Torizuka, Y.; Yamada, K.; Yamamoto, S.; Yoshida, K. (Lab. of Nuclear Science, Tohoku Univ., Mikamine, Sendai 982). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3235-3237(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

This paper describes the Tohoku University 150 MeV pulse stretcher and the results of the test operation. The ring stores a pulsed electron beam from the electron linac and converts it into a continuous one. The test operation has proved that it works successfully. Broadening of the extracted beam in the vertical direction due to a coupling resonance was observed in the early operation. This problem was resolved by readjustment of the tune. And an extracted beam of 1 μA has been obtained with a duty factor of 80%. The energy spread of the extracted beam was measured to be 0.2%.

5274 **Performance of 1-m long/75-mm bore superconducting prototype coils for HERA.** Horlitz, G.; Kaiser, H.; Knust, H.; Mess, K.H.; Schmuser, P.; Wiik, B.H.; Wolff, S. (DESY, Hamburg). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3390-3392(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Two short prototypes of the new HERA superconducting dipole magnets with 75 mm inner bore have been built and tested in a bath cryostat. Both coils have reached the short sample current of the cable after a few training steps. The quench current depends linearly on the temperature between 4.0 and 5.0 K. The field quality of both coils is in general within specifications. There is no current dependence of the higher harmonics except for the well-known hysteresis due to persistent currents.

5275 **Mechanically improved rectangular cable.** Borden, A.R.; Wolgast, R.C. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3399-3401(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Most electrical cables for superconducting magnets are made from round strands twisted into a hollow spiral and compacted into a two layer rectangular cross-section (called Rutherford cable). It is used to make compact electrical coils when a stranded conductor is required. A significant improvement has been conceived and improved cable has been fabricated. The improvement avoids the effect in the Rutherford cable where the round strands are indented into each other during the compacting process. Advantages of the new cable are: Minimum distortion of cable cross-section in making bends; low fraction of voids with minimum distortion of the individual strands; larger area of strand-to-strand contact which decreases plastic flow under compressive force. The advantages apply to conventional conductors as well as superconductors.

5276 **Superconducting combined function magnets.** Hahn, H.; Fernow, R.C. (Brookhaven Nat.'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3402-3404(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Superconducting accelerators and storage rings, presently under construction or in the design phase, are based on separate dipole and quadrupole magnets. It is here suggested that a hybrid lattice configuration consisting of dipoles and combined function gradient magnets would reduce the number of magnet units and their total cost and increase the filling factor and thus the energy at a given field. Coil cross sections are presented for the example of

the Brookhaven Colliding Beam Accelerator. An asymmetric two-layer cable gradient magnet would have transfer functions of 10.42 G/A and 0.628 G cm^{-1}/A versus 15.77 G/A and 2.03 G cm^{-1}/A of the present separate dipoles and quadrupoles.

5277 **A cathode follower power amplifier.** Giordano, S.; Puglisi, M. (Brookhaven Nat.'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3408-3410(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In circular accelerators and particularly in storage rings it is essential that the total impedance, as seen by the beam, be kept below some critical value. A model of the accelerating system was built using a single ended cathode follower amplifier driving a ferrite loaded cavity. The system operated at 234.5 KHz with a peak output voltage of + or - 10 kV on the gap. The dynamic output impedance, as measured on the gap, was < 15 ohms.

5278 **A linear and non linear analysis of high power rf amplifiers.** Puglisi, M. (Brookhaven Nat.'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3411-3413(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

After a survey of the state variable analysis method the final amplifier for the CBA is analyzed taking into account the real beam waveshape. An empirical method for checking the stability of a non linear system is also considered.

5279 **Comparison of three 108-MHZ systems for 1.6 MW.** Hutter, G. (GS1, Gesellschaft fur Schwerionenforschung mbH D-6100 Darmstadt). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3417-3419(Aug 1983). (CONF-830311—).

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Advantages, disadvantages and performance of two completely different amplifier cavity types, together with the three high power tetrodes RS2074SK (Siemens), TH518 (Thomson CSF) and 8973 (Eimac) are reported.

5280 **A 150-kW, 450-MHz gyrocon rf generator.** Tallerico, P.J. (AT-5, MS H827 Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3420-3422(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The output-power and conversion efficiency of the Los Alamos gyrocon were increased by a factor of 150 in the past year. Major improvements in the phase- and amplitude-control system and in understanding the electron multipactor and surface-conditioning processes increased the output power. The highest measured efficiency on this gyrocon is 23%, which was obtained with several combinations of parameters. Both the output power and the efficiency are a factor of 3 below the design values, and several possibilities are being examined to remove the discrepancy between theory and experiment.

5281 **Traveling-wave tube amplifier characteristics study for stochastic beam cooling experiments.** Leskovar, B.; Lo, C.C. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3423-3425(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The characteristics of continuous-wave wideband traveling-wave tube amplifiers have been experimentally investigated over a frequency range of 1.5 to 4.5 GHz. The authors present measurements of characteristics important for stochastic beam cooling systems that are generally not available from manufacturers' data sheets. The amplifiers measured include models 1177 H01 and 1277 H01 having output power capabilities of 10 to 20 W, respectively, at frequencies of 2 to 4 GHz. The power transfer characteristics, the phase-shift characteristics as functions of frequency and the input power level, the voltage standing-wave ratio, harmonics and intermodulation products content were accurately measured and are discussed. Also several approaches are discussed for the reduction of harmonics and intermodulation products.

5282 **Optically pumped polarized ion source with 16.5-GHz ECR ion source.** Mori, Y.; Fukumoto, S.; Ikegami, K.; Takagi, A. (Nat'l Lab. for High Energy Physics, Ohomachi, Tsukuba-gun, Ibaraki-ken 305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2740-2742(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A new type of polarized H^- ion source which uses electron pick-up reactions of a low energy H^+ ion beam from electron-spin polarized sodium atoms has been developed at KEK. The authors have obtained 10 about 25 /sigma phi/A polarized H^- ion beam when the electron-spin polarization of sodium atoms was about (46 about 100) + or - 8%.

5283 **A brighter - source for the intense pulsed neutron source accelerator system.** Stipp, V.; DeWitt, A.; Madsen, J. (Argonne Nat'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2743-2745(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Further increases in the beam intensity of the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory required the replacement of the H^- source with a higher current source. A magnetron ion source of Fermi National Accelerator Laboratory (FNAL) design was adapted with a grooved cathode to provide a stable 40-50 mA of beam operating at 30 Hz for up to a 90 /sigma phi/Ms pulse duration. Problems of space charge blowup due to the lack of neutralization of the H^- beam were solved by injecting additional gas into the 20 keV transport system. The source has recently been installed in the machine and the available input to the accelerator has more than doubled.

5284 **Tests for pulsed high current heavy ion synchrotron injection with an MP-Tandem Van de Graaff.** Thieberger, P.; McKeown, M.; Wegner, H.E. (Brookhaven Nat'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2746-2749(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The new MARK VII high current negative heavy ion source designed by R. Middleton was operated in a pulsed mode to provide 100-200 /sigma phi/a negative ion currents in 230 /sigma phi/sec square pulses, 10/sec. These pulses, 50-100 times more intense than normal DC beams, were then accelerated by the MP7 Tandem Van de Graaff accelerator while operating at 14 MV. After charge state analysis, the emittance of the pulsed beam was also measured. The very stable accelerator behavior indicated that even higher currents are possible. Values for ^{16}O are: 115 /sigma phi/a ^{16}O- injected, 100 MeV $^{16}O^{6+}$, 260 /sigma phi/a (43.3 p/sigma phi/a) 1.8 mmXmr; and for ^{32}S are: 170 /sigma phi/a ^{32}S-injected, 140 MeV $^{32}S^{9+}$, 240 /sigma phi/a (26.7 p/sigma phi/a) 0.51 mmXmr. The high intensity and low emittance of these ion beams make them ideal for injection into a synchrotron like the AGS 30 GeV proton accelerator at BNL.

5285 **Beam transport and targetry in the 1-TEV Fermilab Meson area.** Malamud, E.; Carey, D.C.; Coleman, R.; Eartly, D.; Haggerty, H.; Jonckheere, A. (Fermi Nat.'l Accelerator Lab., P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2775-2777(Aug 1983). (CONF-830311—).

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Three ED/S 1 TeV primary beams will be transported to the Meson Area and targeted in above-ground stations designed for intensities up to 5 X 10^{12} protons/pulse. Muon backgrounds will be reduced to acceptable levels with active shielding. New secondary beams, one providing polarized protons, the other high intensity hadrons, will feed experiments located in new buildings approximately 300 m north of the present Meson Detector Building (MDB).

5286 **Antiproton production and collection for the CERN antiproton accumulator.** Jones, E.; Rohner, F.; Schnuriger, J.C.; Sherwood, T.R.; Van der Meer, S. (CERN 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2778-2780(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Antiprotons are produced for the CERN Antiproton Accumulator (AA) by focusing 26 GeV/c protons onto a 3 mm diameter, 11 cm long copper wire. Negatively charged particles with momenta about 3.5 GeV/c are focused by a short focal length coaxial horn and transported to the AA by a normal quadrupole focusing channel. The yield of antiprotons was found to be considerably less than anticipated (factor about 2) and the reason is presumed to be the assumption of too large a production cross-section in the original machine design proposal. Studies involving new horn design, introduction of an axial current ($\cong$ 150 kA) along the target and use of lithium lenses as an alternative to the magnetic horn are under way. Some preliminary measurements involving some of these techniques have been made, both to confirm the validity of calculations and to test the feasibility of building targets and focusing systems to withstand the mechanical forces and heat load due to the proton beam and the high pulsed currents.

5287 **Relativistic injection into a high-current betatron.** Felber, F.S.; Cooper, R.K.; Fisher, A.; Godfrey, B.B.; Hughes, T.P.; Mitrovich, D.; Vomvoridis, J. (Western Research Corp. 8616 Commerce Ave., San Diego, CA 92121). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2781-2783(Aug 1983). (CONF-830311—).

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A method of injection into betatrons, which employs relativistic beams to overcome space charge limitations, is discussed. The method eliminates the need to modify the betatron with a toroidal magnetic field and avoids the attendant complications. Moreover, multiturn injection can reduce current and power requirements on the injector by orders of magnitude. Multiturn injection by rf linacs, however, may use a substantial fraction of the phase area in a betatron, which requires some means of painting the available phase space and missing the injector on subsequent turns. An example of such a betatron injection system is presented.

5288 **A design for antiproton collection and beam transport in the Fermilab Tevatron I project.** Colton, E.; Hojvat, C. (Argonne Nat.'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2784-2786(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

120 GeV protons from the Main Ring will be used to produce 8 GeV antiprotons. A pulsed lithium lens collects and matches the antiprotons to a beam line for injection into the Debuncher Ring. The p^- beam has a transverse emittance of 20π mm-mr and a $\delta p/p = +$ or -2.0%. The beam line consists of a clean-up section with vertical emittance selection, two long dispersion free sections, a bend and a vertical injector. Antiprotons with a transverse emittance of 2π mm-mr and $\delta p/p = +$ or - 7.0 X 10^{-4} are transported in the reverse direction, bypassing the target area, and along the 120 GeV proton transport line for reverse injection in the Main ring.

5289 **Charge exchange injection at the AGS.** Barton, D.S.; Ahrens, L.A.; Gill, E.; Glenn, J.W.; Reece, R.K.; Witkover, R.L. (Acceleration Dept., Brookhaven Nat.'l Lab., Assoc. Univ.'s Inc., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2787-2789(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The AGS has been brought into operation in October 1982 with multi-turn H^- charge exchange injection. The injection area of the AGS has been modified to bring the H^- beam from the 200 MeV linac through the main magnet fringe field to a stripping foil located within the magnet aperture. The injection system is described in detail and initial performance of the accelerator is reported.

5290 **Performance of the SPS ring vacuum system for colliding beam operation.** Angerth, B.; Flockhart, R.B.; Kouba, G.; Wahl, H. (CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2790-2792(Aug 1983). (CONF-830311—).

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The SPS ring vacuum system was recently upgraded to the vacuum requirements for proton-antiproton collider operation. The new specification stipulated an average operating pressure in the ring of 3.10^{-9} mbar, to be reached within 10 days of pumping after a venting to air. The pressure is expressed in nitrogen equivalent gauge reading. Bakeout to rapidly reduce the gas desorption from the system cannot be used in the SPS, except at a few special positions which cover less than 5% of the ring circumference. The specified pumping time is much shorter than the time it usually takes for an unbaked vacuum system to reach its limit pressure. The pressure thus continues to fall for roughly 3 months from the beginning of a pumpdown and finally settles at about 7.10^{-10} mbar.

5291 **Injection and extraction for SUSE.** Hinderer, G.; Hiuterberger, F.; Kieule, P.; Schott, W.; Triuks, U.; Wilhelm, W.; Zech, E. (Physik-Department der Technischen Universitat, Munchen und Sektion Physik der Universitat, Munchen, 8046 Garching). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2812-2814(Aug 1983). (CONF-830311—).

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The injection onto the first cyclotron orbit differs essentially from injection schemes for normal conducting sector cyclotrons because of two reasons: the central region is occupied by the RF-cavities, and the stray field between the sectors is strongly nonscaling with the mean field level. An appropriate injection and extraction system was developed using a series of superconducting channel magnets which cause practically no field perturbation outside and produce field levels of several Tesla inside. These magnets have a closed structure - like a shielding Faraday box in the electrostatic analogon. Therefore the injection path is below the median plane in the region of the circulating orbits. The accelerated beam will be extracted with an electrostatic septum (10 MV/m). Single turn extraction is achieved primarily by the acceleration voltage of 2 MV/turn, giving a turn-separation of 2.5 mm for 300 MeV/u and Q/A = 0.5. The separation may be increased by coherent betatron-oscillations.

5292 **120-GeV proton transport for antiproton production in the Fermilab Tevatron I project.** Colton, E.; Hojvat, C.; Oleksiuk, L. (Argonne Nat.'l Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2818-2820(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Short bunches of 120 GeV protons will be used for the production of 8 GeV antiprotons. Protons will be extracted vertically from the Main Ring using two high field Lambertson type magnets at location F17. The beam transport is made of three sections: hori-

zontal dispersion cancellation, vertical dispersion cancellation and final focusing. The final focusing section is composed of two quadrupole doublets and allows for variation in B* values at the target from 1.5 m to 20.0 m.

5293 **Antiproton yield optimization in the CERN antiproton accumulator.** Johnson, C.D. (CERN, Geneva). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2821-2823(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The setting-up and optimization of antiprotons injected into the Antiproton Accumulator was initially based upon the measurement of circulating antiprotons by integration of their Schottky signals. This has now been supplemented by amplitude distribution measurements using an internal target. Also, the more readily detectable pions, muons and electrons, injected along with the antiprotons, give information on machine aperture and orbits, which can serve as a monitor of injection conditions during antiproton stacking.

5294 **Mechanical design of the high-energy beam-transport line for the FMIT 2-MeV accelerator.** Liska, D.; Carlisle, L.; Greenwood, D.; Grieggs, R.; McCormick, J.; Sigler, F.; Uher, J.; Zimmerman, G. (AT-4 MS H821, Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2824-2826(Aug 1983). (CONF-830311—).

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The beam-transport line for the high-power 2-MeV Fusion Materials Irradiation Test (FMIT) accelerator is one of the most heavily instrumented ever designed. A wide variety of diagnostics is required to accurately determine the characteristics of the beam that will ultimately be used. Because the machine is only 2 MeV, the packing factor in the high-energy beam transport (HEBT) is high, especially since full-scale FMIT-grade components are used where possible. The HEBT's mechanical design aspects and its instrumentation are described.

5295 **Low momentum kaon beam lines.** Lobb, D.E. (TRIUMF, Physics Dept., Univ. of Victoria, Victoria, B.C. V8W 2YZ). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2827-2829(Aug 1983). (CONF-830311—).

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Current low momentum (about 500 MeV/c) high acceptance (about 5 msr) kaon beam lines feature high ratios of charged contaminant particles to kaons. The results of computer calculations on scattering and pion production from K^0 /SUB S/ decay are presented to indicate some of the sources of this contamination. Criteria for the design of beam lines are discussed and a new beam line design is proposed.

5296 **CBA main magnet power supply ripple reduction.** Bagley, G.; Edwards, R.J. (Brookhaven Nat.'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2923-2925(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The preliminary results of a development program to minimize beam perturbation resulting from ripple current generated by the CBA Main Magnet Power Supply are presented. The assessment of the magnitude and causes of the ripple generated led to a modification of the SCR Gate Driver and the addition of a bandpass amplifier correction loop which gave significant improvement. A description of the changes made and the results obtained are included. A second design approach was developed in which the timing of the SCR gate pulses is directly determined by a VCO. The results reported with this VCO Loop indicate superior performance particularly at frequencies below 60 Hz. A shunt transistor regulator design is proposed to minimize higher SCR switching frequency harmonics.

5297 **Injected beam chopper system for the intense pulsed neutron source accelerator system.** Rauchas, A.; Zolecki, R. (Argonne Nat.'l Lab., Argonne, IL 60539). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2947-2949(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A new chopper system has been designed and built to allow versatile manipulation of the H^- beam for the Intense Pulsed Neutron Source (IPNS) accelerator system. The beam is chopped at an energy of 750 keV, just before injection into the 50 MeV linear accelerator. The system consists of a high speed logic control system, a high power pulse amplifier and a travelling wave beam deflection electrode. The control system allows for up to four concurrently operable functions. The first mode is dedicated to personnel and equipment protection interlocking. The second is for low frequency pulse shaping. The third is a high frequency chop mode for RF synchronized injection of the 50 MeV beam into the Rapid Cycling Synchrotron (RCS). The fourth mode allows width and/or time modulation of the RF synchronized chopping to control the loading of the RF bucket area in the RCS.

5298 **Bending magnets for the CBA beam transport line.** Thern, R.E. (Brookhaven Nat.'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2950-2952(Aug 1983). (CONF-830311—).

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The beam transport line from the AGS to CBA requires 68 large bending magnets, consisting of pure dipoles and two types of combined function gradient magnets. All three types were designed with the magnetic field calculation program POISSON, using the same exterior dimensions and coil package. The design goal of + or - 1% momentum acceptance for the transport line required a wide horizontal aperture, with a much smaller vertical aperture for economy. Two prototypes of one gradient magnet were built, and a facility constructed to measure them and the later production magnets. Measurements were done using both a long coil and a point coil (Rawson-Lush gaussmeter). Preliminary results show $\Delta B/B < 0.2 \times 10^{-3}$, $\Delta G/G < 0.3 \times 10^{-2}$, and $\Delta B_2/B < 0.3 \times 10^{-4}$ cm^{-2} over the beam aperture. Due to end effects, the actual gradient differs from the design gradient by 1%, which has been compensated for in the beam line design.

5299 **The Fermilab injection kicker.** Trendler, R.; Harrison, M.; Needles, C.; Tillis, E.; Williams, W. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2953-2955(Aug 1983). (CONF-830311—).

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This paper describes the proton injection kicker system designed to accept protons from the Fermilab Conventional Main Ring in the Tevatron Superconducting Ring. The pulse forming network (PFN) based thyratron switch tube pulser delivers a 100 ns rise, 200 ns fall, 40 KV pulse to a 6.25 ohm traveling wave magnet load. The pulse duration is adjustable up to a maximum of about22 /sigma phi/sec. The design philosophy, magnet parameters, and system performance are discussed.

5300 **The AGS new fast extraction system and the single bunch extraction test.** Weng, W.T. (Accelerator Dept., Brookhaven Nat.'l Lab., Assoc. Univ.'s Inc., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2956-2958(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

For the neutrino physics program and for the CBA injection, a new fast extraction system has been implemented to improve the extraction efficiency and the quality of the extracted beam. Central to the new system is a new fast kicker, placed at the H5 straight section, capable of rising between bunches, t /SUB r/ < 170 nsec, and staying constant for 2.6 /sigma phi/sec with flat top

ripple less than + or - 1.5%. So far, the system has been operated for longer than 3000 hours and routinely extracts 10^{13} ppp at 99% efficiency. Experiment 745 on QCD test requires a single AGS bunch of 40 nsec. For this purpose another fast kicker was placed at the E5 straight section and powered by a new pulser to produce a half sinusoidal pulse with both a rise and fall time of 200 nsec. A single AGS bunch was extracted through the slow beam channel at 22 GeV/c leaving the remaining 11 bunches undisturbed which continued to be accelerated to 29.4 GeV/c and extracted by the H5 kicker through the fast beam channel. Because the ring circumference ratio of CBA to the AGS is 4-3/4, some of the injected beam from the AGS has to contain 11 bunches instead of 12; consequently, this single bunch extraction mode will also be used for CBA injection.

5301 **Update on the high-current injector for the Stanford linear collider.** James, M.B.; Clendenin, J.E.; Ecklund, S.D.; Miller, R.H.; Sheppard, J.C.; Sinclair, C.K.; Sodja, J. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2992-2994(Aug 1983). (CONF-830311—). Contract AC03-76SF00515.

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The high current injector has become operational. There are two crucial areas where improvements must be made to meet collider specifications. First, while the injector can produce up to $10^{11}e^-$ in a single S-band bucket, initially much of this charge was captured in a low energy tail and was thus not suitable for transport through the accelerator and injection into the damping ring. Second, pulse to pulse position jitter has been observed, resulting in transverse wake fields which increase beam emittance. These problems contribute to substantial current loss during transport from the injector (40 MeV) to the SLC damping ring (1.2 GeV). Experimental studies are continuing with the aim of understanding and improving beam characteristics including bunch length, pulse to pulse stability and emittance. The present status of these studies is reported.

5302 **Transient beam loading calculations and experiment at the Saclay electron linac.** Aune, B.; Leroy, J.; Mosnier, A. (DPh-N/AL, CEN Saclay, 91191 Gif-sur-Yvette, Cedex). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2995-2997(Aug 1983). (CONF-830311—).

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The transformation of the Saclay electron linac (ALS) into an injector for a 2 GeV stretcher ring is under study. One of the problems associated with this transformation is the use of the existing sections in a new mode of operation. The sections were optimized for low current operation (high attenuation, high internal resistance); they will be used in a high current, short pulse (1μs) mode resulting in a prohibitive transient beam loading energy spectrum broadening. The compensation method used at SLAC, which consists in delaying the turn-on of some klystrons, has been studied theoretically and an experiment has been performed with a 1μs pulse, at the same beam loading level as for the future plans.

5303 **Conversion of the AGS linac to H^- acceleration.** Wickover, R.L.; Barton, D.S.; Reece, R.K. (Accelerator Department, Brookhaven National Laboratory, Associated Universities Inc., Upton, New York 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3010-3012(Aug 1983). (CONF-830311—).

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The AGS 200 MeV linac was converted to an H^- accelerator during the summer of 1982 using a magnetron-type source in the column of the second pre-injector pit. Because of the re-entrant electrode design, a 20 keV transport line was required to carry the beam to the first electrode. Several changes were made to the source which enhanced its performance over previous designs. The same H^- beam current is available at 2.75 times the duty factor with reduced deterioration of its output over several months of operation. The source, 750 keV transport, and linac modifications and performance are presented.

5304 **A first order space charge option for TRANSOPTER.** de Jong, M.S.; Heighway, E.A. (Atomic Energy of Canada Limited, Research Company, Chalk River Nuclear Laboratories, Chalk River, Ontario, KOJ 1JO). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2666-2668(Aug 1983). (CONF-830311—).

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TRANSOPTR, a beam transport design code, incorporates automatic optimization of a beam transport system under general constraints. This optimization can be performed for either first order (with or without space charge effects) or second order calculations. Space charge effects are calculated in the x-y plane for continuous beams or in x-y-z space for bunched beams using a new approach. The method integrates a set of differential equations describing the evolution of the beam matrix along the main trajectory where the matrix represents the beam ellipsoid in phase space. A spatially uniform charge density approximation is used and emittance growth is assumed to be negligible. Changes in the optimum beam transport conditions of a system caused by space charge effects can be readily evaluated with this code. Some applications of the code are given.

5305 **Intense antiproton source for a 20-TeV collider.** Lambertson, G.R.; Leeman, Ch.W. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2025-2027(Aug 1983). (CONF-830311—). Contract AC03-76SF00098.

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The feasibility of producing, collecting and cooling p^-'s at a rate $> 3 \times 10^8 s^{-1}$ is demonstrated. This implies a filling time of about 12 hours to reach a luminosity of $\simeq 10^{32} cm^{-2} s^{-1}$ in the collider.

5306 **Computer-animated linac diagnostics and data acquisition.** Yeremian, A.; Adamski, J.; Shoffstall, D. (The Boeing Aerospace Company, Seattle, WA). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2279-2280(Aug 1983). (CONF-830311—).

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Computer interactive diagnostics have been developed and tested for measuring RF Linac electron beam position and emittance. Electron beam position is measured with ferrite-loaded stripline monitors. The measured signals are processed by an APPLE-II computer, displayed and updated (at the Linac repetition rate) on a monitor. Data to determine emittance is collected by measuring electron beam spot size (using the wire scanner technique) as the focal strength of a quadrupole triplet is adjusted around the focus at the scanner. The emittance is calculated by the APPLE-II making a hyperbolic curve fit to these data.

5307 **A multi-channel fibre-optic link for analog telemetry.** Shubaly, M.R.; Plato, J.G. (Atomic Energy of Canada Ltd., Research Co., Chalk River Nuclear Lab.'s, Chalk River, Ontario KOJ 1JO). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2296-2298(Aug 1983). (CONF-830311—).

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Control of an ion beam injector requires a reliable telemetry link for analog signals between the high voltage dome and ground. This paper describes a selfscanning, self-checking system capable of transmitting up to sixteen channels of analog data (in each direction) with eight bit resolution over a dual light link. The technique used is serial transmission of eight bit words using standard UART's (Universal Asynchronous Receiver Transmitter) which provide much of the error detection and timing. Two versions, one stand-alone for manual control, the other an input/output interface

board that plugs into a control microcomputer, have been designed. For sixteen channels, the data is updated every 3.2 milliseconds. The simple design and low parts count provide a low cost analog telemetry system.

5308 **The multiwire secondary emission monitor and the emittance measurement of the AGS beam.** Weng, W.T.; Chiang, I.H.; Smith, G.A.; Soukas, A. (Accelerator Dept., Brookhaven Nat.'l Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2331-2333(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

For CBA injection the transverse emittances and the Twiss parameters of the AGS beam have to be well defined to minimize the phase space dilution in CBA. Although there exists a profile monitor device at U165, there are three reasons why construction of a multiwire profile monitor system at three locations from U500 to U168 is required. The dispersion function is not zero at U165 which makes it harder to interpret the measurement. The original single wire device takes five minutes to traverse the whole beam. Third, a three station multiwire system can provide the profile information at all locations in one pulse which makes on-line analysis possible. A set of three stations of Multiwire Secondary Emission Monitor (MSEM) has been built and installed in the fast external beam line for the measurement of beam profiles. Each unit consists of two planes each with 30 nickel wires having a diameter of 5 mils. The signal is linear within the range of 10^{10} to 10^{13} incident protons on the wire and the resolution of the signal is well within a few percent. A least-square fitting routine has been used to extract the emittance and phase space parameters of the beam. The emittances obtained at various intensities will help to understand the AGS acceleration process and to choose the optimal injection scheme for CBA.

5309 **Muon beams at the LAMPF biomedial channel.** Paciotti, M.A.; Bradbury, J.N.; Rivera, O.M. (Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2359-2361(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Modifications have been made to the LAMPF biomedical channel that allow the delivery of intense muon beams for physics experiments while retaining the design high-flux pion capability. Two types of muon beams have been developed: first, muons from the backward decay of pions and second, "cloud" muons, from the target region, momentum-degraded in the channel to reduce the pion component. Muons are collected from a region between the second and third bending magnets in the channel which can contain a Be degrader. A momentum-dispersed image is formed at a new downstream slit which is used to determine the momentum spread of both types of muon beams. The decay beam provides good polarization and low electron contamination. The degraded beam has higher intensity but about 40% electron contamination. Both beams have a pion contamination of about 3%.

5310 **Monitoring of the Stanford LINAC microbunches' position.** Denard, J.C.; Oxoby, G.; Pellegrin, J.L.; Williams, S. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2364-2366(Aug 1983). (CONF-830311—). Contract AC03-76SF00515.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A new hardware has been developed to measure the trajectory of microbunches along the Stanford Linac. To be suitable for the operation of the SLAC Single Pass Collider, the bunches' absolute position must be kept within + or - 100 microns of the accelerator center, and the acquisition of this measurement must be made along the machine in a snapshot fashion. Typically, the position of three bunches will be monitored during subsequent shots; the authors expect a minimum charge of 10^9 particles per bunch and a time spacing between bunches of 50 nanoseconds. The mechanics of the position detectors is described as well as the general system organization and the calibration of various components.

5311 **Progress of experiment to study the limitations to beam transport in a periodic solenoid focusing channel.** Lawson, J.D.; Chojnacki, E.; Loschialpo, P.; Namkung, W.; Prior, C.R.; Randle, T.C.; Reading, D.H.; Reiser, M. (Rutherford Appleton Lab., Chilton, Oxon). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2537-2539(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

An account is given of work carried out in preparation for an experiment on the transport of a high current electron beam through an array of solenoid lenses. The performance of grids for emittance enhancement and measurements of beam profile and emittance are described. The effects of aberrations and nonlinearities are discussed.

5312 **Studies of heavy ion beam transport in a magnetic quadrupole channel.** Klabunde, J.; Reiser, M.; Schonlein, A.; Spadtke, P.; Struckmeier, J. (GSI, Gesellschaft fur Schwerionenforschung mbH D-6100 Darmstadt). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2243-2545(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In connection with the West German Heavy Ion Fusion Program the first stage (six periods) of a magnetic quadrupole channel (FODO type) to study the transport of intense ion beams was built at GSI. Different ion beams can be used and the variation of the brightness of these beams (hence of the tune depression σ/σ /SUB o/) is sufficiently large that regions of theoretically predicted instabilities can be covered. The initial studies are being carried out with a high-brightness beam of 190 keV Ar+ ions and currents of a few mA. Since the pulse length is > 0.5 ms and the pressure is between 10^{-6} and 10^{-7} torr partial space charge neutralization occurs. Clearing electrodes can be used to remove the electrons from the beam. Results of theoretical studies, measurements of charge neutralization effects and first results of transport experiments are reported.

5313 **A quadrupole beam transport experiment for heavy ions under extreme space charge conditions.** Chupp, W.; Faltens, A.; Hartwig, E.C.; Keefe, D.; Kim, C.H.; Laslett, L.J.; Nemetz, R.; Pike, C.; Rosenblum, S.S.; Shiloh, J. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2549-2551(Aug 1983). (CONF-830311—). Contract AC03-76SF00098.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A Cs ion-beam transport experiment is in progress to study beam behavior under extreme space charge conditions. A five-lens section matches the beam into a periodic electrostatic quadrupole FODO channel and its behavior is found to agree with predictions. With the available parameters the transverse (betatron) oscillation frequency can be depressed down to one-tenth of its zero current value as a function of the beam plasma frequency. The current can be controlled by adjustment of the gun and the emittance can be controlled independently by means of a set of charged grids.

5314 **Means and method for the focusing and acceleration of parallel beams of charged particles.** Maschke, A.W. (to US Department of Energy). US Patent 4,392,080. 5 Jul 1983. Filed date 23 May 1980. vp.

PAT-APPL-152461.

A novel apparatus and method is disclosed for focussing beams of charged particles comprising planar arrays of electrostatic quadrupoles. The quadrupole arrays may comprise electrodes which are shared by two or more quadrupoles. Such quadrupole arrays are particularly adapted to providing strong focussing forces for high current, high brightness, beams of charged particles, said

beams further comprising a plurality of parallel beams, or beamlets, each such beamlet being focussed by one quadrupole of the array. Such arrays may be incorporated in various devices wherein beams of charged particles are accelerated or transported, such as linear accelerators, klystron tubes, beam transport lines, etc.

5315 **A 145 MHz niobium split-ring resonator for particle velocities from 0.12 to 0.23 c.** Shepard, K.; Zinkann, G. (Argonne Nat'l Lab, 9700 South Cass Ave., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 1312-1314(May 1983).

A niobium split ring resonator has been designed with an optimum particle velocity $\beta = v/c = 0.16$. This type of resonator will be used to extend the Argonne superconducting heavy-ion linac. The peak surface electric field in the resonator is 3.9 times the effective accelerating field, a value 20% lower than for previously developed split-ring resonators. A prototype niobium resonator has been completed. Results of performance tests are discussed.

5316 **Application of accelerators in research and industry.** Duggan, J.L.; Morgan, I.L. (eds.). New York, NY; Institute of Electrical and Electronics Engineering, Inc. (1983). 1069p. (DOE/ER/40064—1; CONF-821123—). Inst. of Electrical and Electronic Engineers, Inc., 345 E. 47th St., New York, NY 10017. Contract FG05-82ER40064.

From 7. conference on the application of accelerators in research and industry; Denton, TX, USA (8 Nov 1982).

Abstracts of individual items from the conference were prepared separately for the data base. (GHT)

4304 Storage Rings

REFER ALSO TO CITATION(S) 5233, 5278

5317 **(BNL—33813) Some comments on the design of electron storage rings for free electron lasers.** Krinsky, S. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 9p. (CONF-8309118—3). NTIS, PC A02/MF A01. Order Number DE84002869.

From Topical meeting on free electron generation of extreme ultraviolet coherent radiation; Upton, NY, USA (19 Sep 1983).

We discuss the dependence of the small signal gain of a free electron laser upon the parameters of the storage ring in which it is situated, emphasizing the important limitation imposed by the microwave instability upon the generation of short wavelength.

5318 **Antiprotons in the ISR.** Bryant, P.J. (LEP Division, CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2047-2049(Aug 1983).

A brief account is given of the events leading up to antiprotons in the Intersecting Storage Rings (ISR) followed by a synopsis of the characteristics and parameters of the physics runs made to date. Experience gained with critical operations, such as transfer line steering, injection optimization, stacking and phase displacement acceleration is reviewed bearing in mind the extremely low beam intensities. Special reference is made to the various machine improvements, namely the vertical transverse stochastic cooling for proton beams of up to 12 A, the transverse and longitudinal stochastic cooling for the antiprotons, the new antiproton beam position monitoring system in the transfer lines and ring and the use of two high-luminosity insertions. At the end of June 1982, a scheme for reaching higher luminosities by making multiple transfers from the Antiproton Accumulator (AA) and using longitudinal stochastic cooling in the ISR was demonstrated. The absence of any measurable loss rate during long periods of stable beam conditions has been used to set a new lower limit of 1000 h on the antiproton lifetime at rest. Finally, preparations are in progress to collide 3.5 to 6.5 GeV/c antiprotons with a hydrogen gas jet target.

5319 **Measuring and manipulating an accumulated stack of antiprotons in the CERN antiproton accumulator.** Johson, R.; van der Meer, S.; Pederson, F. (CERN, CH-1211, Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2123-2125(Aug 1983).

The antiproton stack is observed through Schottky scans, both longitudinal and transverse. A particular feature is the wide dynamic range needed for observing both the dense core and the freshly-deposited tail. Separating batches of antiprotons from the stack (unstacking) is a highly automated process including the measurement of the momentum distribution and the generation of a suitable RF function to remove a slice of the desired density. Multiple slices may be removed successively and a process for locally flattening the distribution to obtain equal batch intensities is used. When successive batches are unstacked and ejected, the process may have to be aborted if the particles do not arrive correctly at the user. A "restack" facility is provided to return any antiprotons to the stack that have been unstacked but not ejected. A missing-bucket scheme for unstacking low-intensity batches for LEAR is also described.

5320 **First operational experience with DORIS II.** Nesemann, H.; Wille, K. (Deutsches ElektronenSynchrotron, DESY Hamburg). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 1998-2000(Aug 1983).

DORIS II is a completely new designed e^+-e^- storage ring with a mini-beta scheme. After first runs with a 8 cm optic, the vertical amplitude functions in the interaction points were reduced to 4 cm. This yielded luminosities of $L = 1.5 \times 10^{31}$ cm^{-2}sec^{-1} with 2 X 27 mA at E = 5 GeV. Because of the short injection time, an integrated luminosity of more than 600 nb^{-1} per day has been obtained.

5321 **Recent improvements in luminosity at PEP.** Helm, R.; Allen, M.; Chao, A.; Donald, M.; Kheifets, S.; Martin, T.; Miller, R.; Morton, P. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2001-2003(Aug 1983). Contract AC03-76SF00515.

The authors describe improvements which have led to new records for peak and average luminosity at PEP. Comparison of recent results with several earlier lattice and optical modifications shows rather good correlation with the predictions of a beam-beam simulation program.

5322 **The control system for LEP.** Crowley-Milling, M.C. (European Org. for Nuclear Research (CERN), 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2142-2146(Aug 1983).

There are three main ways in which the requirements for the LEP control system differ from systems that have been built in the past. These include the great distances involved with a ring 26.6 km in circumference, the introduction of microprocessors into the equipment itself and the long time scale at a time when progress in electronics is rapid, with the cost of hardware falling every year without any corresponding fall in the cost of specialized software. In view of this, there are many detailed decisions which cannot be made or implemented at the moment, but the basic principles have been laid down and a number of developments and investigations have been launched. In this paper, the effects of the introduction of microprocessors, the principles of the LEP control system, and the work in progress are discussed.

5323 **Design of an 8-GeV accumulator ring for the Fermilab Fevatron I project.** Ando, A; Collins, T.L.; Johnson, D.E. (Fermi Nat.'l Accelerator Lab., P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2031-2032(Aug 1983).

The design of a 75-m radius, 8-GeV storage ring to be used for stochastic cooling and accumulation of antiprotons is described.

The stochastic cooling systems have imposed strenuous requirements on the lattice and the resulting ring design is rather novel.

5324 **Observation of the beam-beam limit in CESR.** Seeman, J.; Adams, K.; Aharonian, G.; Billing, M.; Blum, E.; Decker, G.; Giannella, M.; Jackson, G.; Littauer, R.; McDaniel, B. (Cornell Univ., Ithaca, New York 14853). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2033-2035(Aug 1983).

CESR has produced e^+e^- collisions for high energy physics in the very productive Y region (4.7 to 5.7 GeV per beam) since the fall of 1979. The peak luminosity recorded during physics data taking over that period is shown. The dramatic increase in the luminosity has resulted from the reduction of β /SUB y/ * from 11 cm to 3 cm, an increase in σ /SUB x/ *, and increases in the vertical aperture. Furthermore, observations of the beam-beam interaction show that the luminosity increases as the square of the beam current at low currents and linearly with current at high currents. These observations are consistent with a vertical beam size which is constant at low currents and increases linearly at high currents. A linearly increasing vertical beam size implies a constant vertical tune shift. The luminosity and the beam lifetime are limited by non-gaussian tails which reach the physical aperture of CESR.

5325 **Operational experience with the superconducting high-luminosity insertion in the CERN intersecting storage rings (ISR).** Billan, J.; Bryant, P.J.; Guignard, G.; Henrichsen, K.N.; Laeger, H.; Lebrun, Ph.; Pichler, S.; Resegotti, L.; Risselada, T.; Tortschanoff, T. (LEP Division, CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2036-2038(Aug 1983).

The eight superconducting quadrupoles and their cryogenic equipment for this insertion were installed in the ISR at the end of 1980. The insertion has been used to assess the problems of running a superconducting insertion in a storage ring as well as to provide high luminosity for physics. The luminosity was increased at intersection 8 by a factor of 7. By means of dedicated collimators and orbit corrections, safe working conditions could be established for the superconducting magnets during injection, accumulation, stable beam periods and when dumping the beams. Quenches were mainly caused by large accidental beam losses. Operating parameters for all standard beam energies, including acceleration to 31.4 GeV/c, have been established. At 26.6 GeV/c, with currents of 30.6 A in ring 1 and 30.3 A in ring 2, a luminosity of 1.4 10^{32} $cm^{-2}s^{-1}$ was obtained in the insertion. This is the highest luminosity reached so far in storage rings and it was obtained during a physics run. Satisfactory beam conditions could also be provided for antiproton physics at 26.6 GeV/c in ISR with both low-β insertions on, in I1 and I8, respectively.

5326 **The lattice design of the LEP electron positron accumulator (EPA).** Delahaye, J.P.; Krusche, A. (CERN, Geneva). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2050-2052(Aug 1983).

In large accelerators, the lattice cell is generally made as simple as possible. Special requirements are then fulfilled by appropriate insertions (dispersion suppressors, low β schemes, wigglers, etc.). In small machines, where space is limited, the lattice cell itself has to deal with all the machine constraints and requirements. The lattice design method developed consists of splitting the superperiod into specialized sections. Each section is built up to fulfill some of the basic requirements, then matched to the neighbouring sections. The best parameter values are deduced from systematic variation in the analytical expression of the corresponding beam transfer matrix. Applied to the LEP Electron Positron Accumulator (EPA), this method was very efficient in optimizing a large number of constraints.

5327 **The IUCF cooler - A storage ring with electron cooling for internal target experiments.** Pollock, R.E. (Dept. of Physics Indiana Univ., Bloomington, IN 47405). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2056-2060(Aug 1983).

A project to construct a ring to store beams of light ions with magnetic rigidities up to 3.6 T-m is underway at the Indiana University Cyclotron Facility. Beams from the cyclotron will fill the ring, be adjusted in energy, then cooled by electron immersion while impinging on thin targets within the ring for nuclear interaction experiments. The motivation is to explore the potential for improved resolution and reduced background of the cold storage technique. The status of the project and of selected subsystem designs will be presented.

5328 **Beam stocking experiments at TARN.** Katayama, T.; Chida, K.; Hattori, T.; Mirao, Y.; Kadota, S.; Mizobuchi, A.; Murakami, T.; Nakanishi, T.; Noda, A.; Takanaka, M. (Inst. for Nuclear Study, Univ. of Tokyo, Tanashi, Tokyo 188). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2080-2082(Aug 1983).

TARN is a low energy, around ten MeV/nucleon, ion storage ring aimed at beam accumulation in both the longitudinal and transverse phase spaces from the injector cyclotron. Up to now, proton, H_2^+, α and $^3He^+$ beams have been stored and the close agreements are shown between the theoretical and experimental results on the beam dynamics. Twenty turn beams are injected in the betatron phase space area of 87 πmm X mrad by the multiturn injection method and 15 pulses are RF stacked in the momentum space $\Delta p/p$ of 2.2%. The overall stacking number is then attained at around 300 turns. RF stacking is performed with the repetition rate of 30 Hz and it requires about 0.5 seconds to fill the whole phase spaces with the beam. The e-folding life time of 7 MeV protons is 400 s at the vacuum pressure of 1 X 10^{-10} Torr, whereas that of $^3He^+$ of the ^4He gas target is 60 ms at 1 x 10^{-8} Torr. Collision strengths of charge exchange atomic reactions have been measured.

5329 **Permanent magnet storage rings for microlithography and FEL sources.** Le Duff, J.; Petroff, Y. (Laboratoire de l'Accelerateur Lineaire, Univ. de Paris-Sud, 91405 Orsay). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3060-3062(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Permanent magnet technology is rapidly improving and it seems possible now to design and build dedicated electron storage rings for peculiar applications such as microlithography and free electron laser. A low capital cost as well as a low operational cost (no power supplies) may lead to industrial solutions. In this paper the authors describe two possible design studies for machines at energies of 240 and 500 MeV with some indications on an efficient injector.

5330 **An all wiggler and undulator synchrotron radiation source.** Winick, H.; Bachrach, R.; Bienenstock, A.; Cerino, J.; Halbach, K.; Hodgson, K.; Lindau, I.; Wiedemann, H. (Stanford Synchrotron Radiation Lab., (SSRL) SLAC Bin 69, Stanford CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3097-3099(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Successful experience with wiggler and undulator (w/u) magnets as synchrotron radiation (SR) sources has led to new facility design concepts. The authors review the design features and performance criteria of new rings and describe a proposed facility at SLAC consisting of two rings (1-2 and 5-6 GeV) in the same tunnel, both optimized for w/u insertions. They also present conceptual designs for permanent magnet dipoles and quads.

5331 **The beam line VI REC-steel hybrid wiggler for SSRL.** Hoyer, E.; Chan, T.; Chin, J.W.G.; Halbach, K.; Kim, K.J.; Winick, H.; Yang, J. (Lawrence Berkeley Lab., Univ. of Cal., Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 3118-3120(Aug 1983). (CONF-830311—). Contract AC03-76SF00098;AC03-82ER13000.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A wiggler magnet with 27 periods, each 7 cm long which reaches 1.21 T at a 1.2 cm gap and 1.64 T at 0.8 cm gap has been designed and is in fabrication. Installation in SPEAR is scheduled for mid 1983. This new wiggler will be the radiation source for a new high intensity synchrotron radiation beam line at SSRL. The magnet utilizes rare-earth cobalt (REC) material and steel in a hybrid configuration to achieve simultaneously a high magnetic field with a short period. The magnet is external to a thin walled variable gap stainless steel vacuum chamber which is opened to provide beam aperture of 1.8 cm gap at injection and then closed to a smaller aperture (<1.0 cm). Five independent drive systems are provided to adjust the magnet and chamber gaps and alignment. Magnetic design, construction details and magnetic measurements are presented.

5332 **Sequential bunch extractions in the Los Alamos PSR.** Wang, T.F.; Cooper, R.K.; Smith, L. (AT-6, MS H829, Los Alamos Nat.'l Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2610-2612(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In the short-bunch, high-frequency operating mode of the future Proton Storage Ring (PSR) at LAMPF, the extraction scheme will take out one bunch at a time. Because the ring only stores six bunches at most and because the bunching system is heavily beam loaded, each extraction can cause a substantial change in the average beam current and hence affects significantly the total bunching voltage as well as the phase synchronization between those remaining bunches and the voltage waveform. A time-dependent cavity-tuning scheme has been considered to retain the proper bunching voltage and phase relation. This work examines the stability of the phase synchronization in the transient stage of extraction and cavity tuning. An equivalent circuit model is adopted, and the coupled nonlinear differential equations are solved numerically. The authors find that the relative phase will remain stable and that the voltage variation is tolerable under the PSR proposed operating conditions. A comparison between the numerical and analytical solutions confirms the numerical results.

5333 **RF exercises associated with acceleration of intense antiproton bunches at Fermilab.** Griffin, J.E.; MacLaclan, J.A.; Qian, Z.B. (Fermilab, P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2627-2629(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Antiprotons for the Fermilab p^-p colliding beam project (Tevatron I) will be extracted from an 8 GeV accumulation ring in a few (1 to 3) bunches of about 10^{11}, a single bunch at a time. To preserve the stack as a source of subsequent bunches, each bunch will be removed from the dense core of the stack with an isolated bucket at harmonic number h = 2. The longitudinal emittance of the bunches will be in range 1.5 to 2.0 eV, roughly five times what the Main Ring usually accelerates with the installed 53 MHz rf system. Therefore, the bunch is to be narrowed on the Accumulator extraction orbit to match a 2.5 MHz bucket in the Main Ring. By raising the 2.5 MHz voltage (harmonic number h = 53), the bunch will be further narrowed in the Main Ring to span seven buckets of the principal system (h = 1113). The bunch will then be captured adiabaically from the h = 53 bucket into seven adjacent h = 1113 buckets for acceleration to a 150 GeV flattop. At this energy the 2.5 MHz and 53 MHz systems will be used jointly to coalesce the seven bunches into a single h = 1113 bucket for injection into the Energy Doubler. This paper describes unstacking in the Accumulator, the adiabatic capture into seven bunches in the Main Ring, and the coalescing of the seven back into one bunch at 150 GeV. The expected performance of the whole sequence has been established by detailed particle tracking simulation, and tests of some phases have been made in the Main Ring.

5334 **Time and momentum exchange for production and collection of intense antiproton beams at Fermilab.** Griffin, J.; MacLachlan, J.; Ruggiero, A.G.; Takayama, K. (Fermilab, P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2630-2632(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Antiprotons for the Fermilab p^-p colliding beam project are accumulated by rf stacking of successive 8 GeV antiproton batches in a storage ring using stochastic cooling to reduce both transverse and longitudinal emittance. The rate of accumulation is increased 15-fold by interchange of bunch length and momentum spread of the antiproton bunches in a special purpose debuncher ring. Tightly bunched antiprotons are produced at the target by 120 GeV protons from the Main Ring. From 2.5×10^{12} protons every 2 seconds the debuncher receives 7×10^7 antiprotons within a momentum bite $\Delta p/p = 3\%$. These antiprotons are injected into mismatched stationary rf buckets in the debuncher so that synchrotron oscillation produces bunch rotation. After 90° of rotation followed by adiabatic debunching, the narrow time spread has been converted into a momentum spread $\Delta p/p = .2\%$. The authors describe the rf technique used to shorten the bunches of the primary proton beam in the Main Ring and report test results. They also describe the complementary procedures to be used in the Debuncher and demonstrate the expected reduction of the momentum spread by particle tracking simulation.

5335 **Tackling transverse coherent instabilities of co- and counter-rotating beams in the CERN antiproton accumulator.** Pedersen, F.; Pirkl, W.; Schindl, K. (CERN, 1211 Geneva 23). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2343-2345(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

In the CERN Antiproton Accumulator, transverse instabilities set in at circulating intensities as low as 10^{10} $p(p^-)$, mainly because of the unusually small variation of Q vs. momentum. The bunched p "test" beam is lost due to head-tail instabilities, and vertical coasting beam modes of the p^- stack lead to an intolerable emittance growth. Based on estimated AA transverse impedances, a fairly simple feedback system was built. Particular features are low power requirements (10 W); housing the electronics outside the tunnel; a "double damper" arrangement enabling the system to tackle simultaneously the p^- stack and the counter-rotating p test beam; and the system's use for controlled beam blow-up to determine machine apertures. Whereas the measured growth rates match the resistive wall impedance, significantly higher damping rates are required to eliminate all coasting beam modes, for yet unknown reasons.

5336 **Beam position measurement in the photon factory storage ring.** Katsura, T.; Nakagawa, H.; Shibata, S. (KEK, National Laboratory for High Energy Physics, Oho-machi, Tsukuba-gun, Ibaraki-ken, 305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2353-2355(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A beam position monitoring system has been constructed for the 2.5 GeV electron storage ring in the Photon Factory. Since the first beam was stored at design energy on March 11, 1982, the position monitor system has been used for orbit measurements during routine operation and during machine studies. The authors confirmed that the accuracy and reproducibility of the system is within 0.2 mm.

5337 **Beam diagnostics of the TRISTAN accumulation ring.** Leiri, T.; Ishii, H.; Mizumachi, Y.; Ogata, A.; Pellegrin, J.L.; Tejima, M. (National Laboratory for High Energy Physics, Oho-machi, Tsukuba-gun, Ibaraki-ken, 305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2356-2358(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The beam diagnostic system of the TRISTAN Accumulation Ring consists of beam position monitors, visible radiation monitors, x-ray monitors, tune measurement setup, etc.. Eighty-six position monitors are installed around the ring. For the closed orbit measurement, a superheterodyne circuit is used to pick up the 479-th harmonic of the revolution frequency (795 kHz) out of beam pulse trains. Synchrotron light is observed in the visible region and in the x-ray region. Visible radiation is used in three ways: profile monitoring by TV cameras, beam current measurement and bunch shape observation by a streak camera. In the x-ray channel a multi-wire ionization chamber is used to get a digitized profile of the x-ray source. Stripline pickups are installed to detect transverse oscillations of e^+ and e^- bunches. The envelope signal of pulse trains will be sent to an FFT processor for tune number identification. At the same time the signals are amplified and fed back to wideband deflection electrodes for damping of the oscillaitons.

44 INSTRUMENTATION

4401 Radiation Instrumentation

REFER ALSO TO CITATION(S) 4684, 5120, 5121, 5492

5338 **(BNL—33523) Semiconductor drift chamber: an application of a novel charge transport scheme.** Gatti, E.; Rehak, P. (Brookhaven National Lab., Upton, NY (USA)). Aug 1983. Contract AC02-76CH00016. 23p. (CONF-8306110—4). NTIS, PC A02/MF A01. Order Number DE84002875.

From 2. Pisa meeting on advanced detectors; Castiglione della Pescaia, Italy (2 Jun 1983).

The purpose of this paper is to describe a novel charge transport scheme in semiconductors in which the field responsible for the charge transport is independent of the depletion field. The application of the novel charge transport scheme leads to the following new semiconductor detectors: (1) Semiconductor Draft Chamber; (2) Ultra low capacitance - large semiconductor x-ray spectrometers and photodiodes; and (3) Fully depleted thick CCD. Special attention is paid to the concept of the Semiconductor Draft Chamber as a position sensing detector for high energy charged particles. Position resolution limiting factors are considered, and the values of the resolutions are given.

5339 **(BNL—33766) Progress in the development of scintillating optical fibers.** Borenstein, S.R.; Strand, R.C. (York Coll., Jamaica, NY (USA); Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-831015—21). NTIS, PC A02/MF A01. Order Number DE84002873.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1983).

Starting with 1 inch diameter PVT scintillator as a preform, the authors have drawn fibers of several diameters ranging from 1 to 4 mm. These fibers have been coated in line with the draw to form optical fibers. Several cladding materials whose index of refraction ranges from 1.35 to 1.55 have been used. The most successful fiber has been obtained with an extra thick (200 micron) cladding of silicone in combination with a linear draw, as opposed to a spool draw. This fiber is acceptable, but it is extremely fragile and its quality is difficult to control. The authors are currently constructing a 12 channel hodoscope with 1 mm spatial resolution using 4 mm diameter fibers. An account is also given of the progress made in using the Avalanche Photo Diode (APD) operated in the Geiger mode as the photo detector.

5340 **(BNL—33858) Inversion for the attenuated radon transform with constant attenuation.** Kim, K.I.; Tewarson, R.P.; Bizais, Y.; Rowe, R.W. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA)). 1983. Contract AC02-76CH00016. 6p. (CONF-831015—20). NTIS, PC A02/MF A01. Order Number DE84002863.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1983).

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An exact form of the inversion formula for the attenuated Radon transform with constant attenuation in a convex domain for use in Single-Photon Computerized Tomography is presented. This problem is reduced to solving a generalized Abel integral equation and the conditions for the existence of a unique continuous solution are given. Implementation of this method involves a preprocessing step (modified attenuated Radon transform), a convolution by an attenuation-dependent function and a weighted backprojection. Therefore, only slight modifications of existing reconstruction algorithms are needed. If the attenuation is zero, this formula reduces to Radon's original inversion formula. When attenuation is not constant, the conditions for a unique continuous solution can be established with a similar approach. Many results found empirically by previous authors are consistent with this theory.

5341 **(BNL—33872) High accuracy gaseous x-ray detectors.** Smith, G.C. (Brookhaven National Lab., Upton, NY (USA)). Nov 1983. Contract AC02-76CH00016. 26p. (CONF-830910—8). NTIS, PC A03/MF A01. Order Number DE84003677.

From 3. national conference on synchrotron radiation instrumentation; Upton, NY, USA (12 Sep 1983).

An outline is given of the design and operation of high accuracy position-sensitive x-ray detectors suitable for experiments using synchrotron radiation. They are based on the gas proportional detector, with position readout using a delay line; a detailed examination is made of factors which limit spatial resolution. Individual wire readout may be used for extremely high counting rates.

5342 **(BNL—33907) Photoelectron range limitations to the spatial resolution for x-rays in gas proportional chambers.** Smith, G.C.; Fischer, J.; Radeka, V. (Brookhaven National Lab., Upton, NY (USA)). Nov 1983. Contract AC02-76CH00016. 6p. (CONF-831015—22). NTIS, PC A02/MF A01. Order Number DE84003163.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1983).

Measurements have been made, for x-ray energies from a few keV to 18 keV, of the limiting spatial resolution caused by the finite range of the photoelectron, or electrons, created when an x-ray is absorbed in the gas of a proportional chamber. In hydrocarbon gases such as methane and ethane, where the photoelectron receives the bulk of the x-ray energy, the limiting spatial resolution is found to vary as a power law of x-ray energy. In argon and xenon, at an x-ray energy approximately twice that of the A/sub K/ edge and the Xe/sub L/ edge respectively, the measured limiting resolution is better than expected from an equivalent power law behavior.

5343 **(CONF-831015—23) Bismuth germanate's role in the new revolution in gamma-ray spectroscopy.** Johnson, N.R.; Baktash, C.; Lee, I.Y. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01. Order Number DE84003326.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1983).

Some of the considerations on how to effectively incorporate bismuth germanate into complex detection systems are covered, and some of these new systems now in operation or under construction are discussed. Significant achievements in gamma ray spectroscopy are reviewed as well as some recent results based on data taken with coincidence arrays of germanium detectors and Compton-suppression spectrometers. Then the first impact of bismuth germanate detectors on our understanding of the properties of nuclei that have high energy and very high angular momentum states are addressed. (LEW)

5344 (DOE/ER/03274—4, pp 82-87) **Progress on the gas Cherenkov system for the detection of single electrons produced in proton-nucleus collisions.** Hallman, T.; Madansky, L. 1983. NTIS, PC A07/MF A01.

In Nuclear moments and nuclear structure. Annual progress report, September 1, 1982-August 31, 1983.

The design and performance of gas Cherenkov counters to be used as triggers in the TASS spectrometers are briefly discussed.

The system is designed for the detection of single electrons in proton-nucleus collisions. (KAW)

5345 **(EGG-PHYS—5735) Precise efficiency calibration of Ge semiconductor detectors for 30 to 2800 keV γ-rays.** Helmer, R.G. (EG and G Idaho, Inc., Idaho Falls (USA)). Nov 1983. Contract AC07-76ID01570. 55p. NTIS, PC A04/MF A01. Order Number DE84002919.

To meet the needs of some of our programmatic activities in precise radionuclide metrology and to support other EG and G Idaho, Inc. organizations at the Idaho National Engineering Laboratory, the Nuclear Physics Section of the Physical and Biological Sciences Division has for many years maintained a capability for precise γ-ray intensity measurements. Over the past three years a major emphasis of this work has involved the calibration of two Ge detectors for the measurements of emission rates of γ rays between 30 and 2800 keV. These calibrations involved over 20 sources, 20 nuclides and 60 γ rays with energies from 14 to 2754 keV. In this report, we give the magnitudes of the various corrections to the measured data, and the components of the uncertainty in the efficiency are discussed. As a result of this work the detector efficiency for point sources can be defined, at the calibration time, with uncertainty varying from 2% below 85 keV to 0.5% from 400 to 1400 keV. Corrctions to these point-source efficiency functions for disk-source geometries are given. The efficiencies of both detectors have been observed to change with time in an energy-dependent manner.

5346 **(KIYI—81-24) Ways of improving semiconductor detectors.** (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). 1981. 62p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE84780037.

Separate abstracts were prepared for papers concerning ways of improving semiconductor detectors. (KAW)

5347 **(PNL-SA—11358) Ultralow background germanium gamma-ray spectrometer using superclean materials and cosmic-ray anticoincidence.** Reeves, J.H.; Hensley, W.K.; Brodzinski, R.L.; Ryge, P. (Pacific Northwest Lab., Richland, WA (USA); Princeton Gamma-Tech, Inc., NJ (USA)). Oct 1983. Contract AC06-76RL01830. 16p. (CONF-831015—24). NTIS, PC A02/MF A01. Order Number DE84003342.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1983).

Efforts to measure the double beta decay of ^{76}Ge as predicted by Grand Unified Theories have resulted in the development of a high resolution germanium diode gamma-ray spectrometer with an exceptionally low background. This paper describes the development of this system and how these techniques can be utilized to significantly reduce the background in high resolution photon spectrometers at only a moderate cost.

5348 **Neutron flux profile monitor for use in a fission reactor.** Kopp, M.K.; Valentine, K.H. (to U S Department of Energy). US Patent 4,404,164. 13 Sep 1983. Filed date 15 Sep 1981. vp.

PAT-APPL-302338.

A neutron flux monitor is provided which consists of a plurality of fission counters arranged as spaced-apart point detectors along a delay line. As a fission event occurs in any one of the counters, two delayed current pulses are generated at the output of the delay line. The time separation of the pulses identifies the counter in which the particular fission event occured. Neutron flux profiles of reactor cores can be more accurately measured as a result.

5349 **Radiation detector.** Fultz, B.T. (to US Department of Energy). US Patent 4,393,306. 12 Jul 1983. Filed date 5 Dec 1980. vp.

PAT-APPL-213276.

Apparatus is provided for detecting radiation such as gamma rays and X-rays generated in backscatter Mossbauer effect spectroscopy and X-ray spectrometry, which has a large "window" for detecting radiation emanating over a wide solid angle from a specimen and which generates substantially the same output pulse height for monoenergetic radiation that passes through any portion of the detection chamber. The apparatus includes a substantially toroidal chamber with conductive walls forming a cathode, and a wire anode extending in a circle within the chamber with the anode lying closer to the inner side of the toroid which has the least diameter than to the outer side. The placement of the anode produces an electric field, in a region close to the anode, which has substantially the same gradient in all directions extending radially from the anode, so that the number of avalanche electrons generated by ionizing radiation is independent of the path of the radiation through the chamber.

5350 **Hyper-filter-fluorescer spectrometer for x-rays above 120 keV.** Wang, C.L. (to US Department of Energy). US Patent 4,393,512. 12 Jul 1983. Filed date 7 Jul 1981. vp.

PAT-APPL-281141.

An apparatus utilizing filter-fluorescer combinations is provided to measure short bursts of high fluence x-rays above 120 keV energy, where there are no practical absorption edges available for conventional filter-fluorescer techniques. The absorption edge of the prefilter is chosen to be less than that of the fluorescer, i.e., E / SUB PRF/ <E /SUB F/ contrary to the prior art technique E / SUB PRF/ >E /SUB F/ . In this way, the response function is virtually zero between E /SUB PRF/ and E /SUB F/ and well defined and enhanced in an energy band of less than 1000 keV above the 120 keV energy.

4403 Miscellaneous Instruments

REFER ALSO TO CITATION(S) 5132

5351 **(CONF-8310172—5) Soft x-ray emission spectroscopy using synchrotron light excitation.** Callcott, T.A.; Ederer, D.L.; Arakawa, E.T. (Tennessee Univ., Knoxville (USA). Dept. of Physics; National Bureau of Standards, Washington, DC (USA); Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01. Order Number DE84003328.

From Advances in soft x-ray science and technology conference; Upton, NY, USA (17 Oct 1983).

Special problems affecting the design of spectrometers used to acquire synchrotron light excited soft x-ray emission spectra are discussed, and a high efficiency, high resolution spectrometer especially designed for this use is described. The special advantages of soft x-ray emission spectroscopy and of synchrotron light for exciting emission are outlined. Several types of experimental investigations that would benefit from the use of photon excitation and a high efficiency spectrometer are discussed. 28 references.

5352 **(SLAC-TN—83-12) Measurement errors in TDC's using digital techniques.** Innes, W.R. (Stanford Linear Accelerator Center, CA (USA)). Oct 1983. Contract AC03-76SF00515. 4p. NTIS, PC A02/MF A01. Order Number DE84002133.

This note discusses the measurement errors in time to digital converters using digital techniques such as scalers or shift registers. In either case the number of periodic events (clock transitions) occurring between start and stop inputs are counted. The discrete nature of this counting results in a digitizing error.

5353 **High temperature pressure coupled ultrasonic waveguide.** Caines, M.J. (to US Department of Energy). US Patent 4,392,380. 12 Jul 1983. Filed date 11 Feb 1981. vp.

PAT-APPL-233354.

A pressure coupled ultrasonic waveguide is provided to which one end may be attached a transducer and at the other end a high temperature material for continuous ultrasonic testing of the material. The ultrasonic signal is coupled from the waveguide into the material through a thin, dry copper foil.

5354 **(LA-tr—83-25) Numerical simulation and practical testing of a rotation-symmetric ion source for gas mass spectrometers.** Baur, H. (Los Alamos National Lab., NM (USA); Zurich Univ. (Switzerland)). 1983. Contract W-7405-ENG-36. Translation source information not available . 107p. NTIS, PC A06/MF A01. Order Number DE84002925.

Translation of Doctoral dissertation in natural science. Submitted to Eidgenoessischen Technischen Hochschule, Zurich, 1980.

A computer program for the simulation of axially symmetric ion sources without an auxiliary magnetic field has been developed. The program handles the motions of electrons and ions in two separate steps. In each step the initial conditions of about 10^4 electrons or ions are sampled by means of random numbers. The trajectories of the particles are calculated including the effect of space charge by successively solving Poiscon's equation and Newton's law of motion for finite time intervals. The performance data (e.g. emittance, transmission etc.) of a simulated source results from a subsequent statistical analysis of particle coordinates in phase space. The model has been applied to improve an ion source with insufficient pressure linearity. Many geometric versions of the source have been examined. For three selected cases results of the simulation are reported here. One source has been constructed and its emittance has been matched to the acceptance of a mass spectrometers flight tube using a cyclinder lens. The sensitivity of the real source, run with 250 μA electron emission, amounts to 8.8 +- 0.4 μA/Pa argon measured at the collector of the mass spectrometer. The sensitivity drops (0.75 +- 0.1) % when the space charge is increased by an amount equivalent to a rise in argon pressure from 2.7×10^{-7} Pa to 8.3×10^{-5} Pa. This is accomplished by admitting an appropriate amount of helium to the statically operated mass spectrometer. Numerical simulation gives a (1 +- 0.3) % decrease of the sensitivity.

45 EXPLOSIONS AND EXPLOSIVES

4501 Chemical

5355 **(MLM—3121) Determination of amide content in 2-[5-cyanotetrazolato]pentammine cobalt(III) perchlorate by high performance liquid chromatography on polyamide.** Schumacher, R.J.; Bullock, K. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 16 Nov 1983. Contract AC04-76DP00053. 7p. NTIS, PC A02/MF A01. Order Number DE84003133.

A relatively new explosive material, 2-[5-cyanotetrazolato]pentammine cobalt (III) perchlorate (CP), undergoes a deflagration-to-detonation transition. An impurity 2-[5-carboxamidetetrazolate]pentammine cobalt (III) perchlorate, CP amide, which is an hydrolysis product, is present and, above a certain level, confers undesirable firing characteristics. An HPLC method was developed utilizing a polyamide column to quantify the amide in chromatographic runs requiring less than 15 min for each determination. The α value for the separation is 4.6. A detection limit of less than 80 ng was obtained.

5356 **(PNL—4459) Hazard-classification test of the cartridge, 120-mm, APFSDS-T, XM829.** Hooker, C.D.; Hadlock, D.E.; Mishima, J.; Gilchrist, R.L. (Pacific Northwest Lab., Richland, WA (USA)). Nov 1983. Contract AC06-76RL01830. 71p. NTIS, PC A04/MF A01. Order Number DE84002168.

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Research was conducted to determine the behavior of the ammunition XM829 when subjected to detonation of an adjacent XM829 cartridge, and a sustained hot fire. It was concluded that the functioning of an XM829 cartridge, in one shipping container, will not cause immediate functioning of XM829 cartridges in adjacent containers. However, if a fire results and is sustained, adjacent cartridges may ignite, resulting in some scattering of debris within a maximum radius of 40 feet. Further, the XM829 cartridge can be expected to remain in a kinetic controlled regime with vigorous oxidation occurring early in such a fire but dropping off as the temperature cools toward ambient. Mass balance analyses data indicated a recovery of at least 80% in the 1982 external heat; in the 1983 test, the recovery percentage was improved to approximately 100% of the original depleted uranium weight volume. Therefore, it may be concluded that a significant airborne release of the depleted uranium material did not occur.

5357 **(SAND—83-1684) Consolidation of Al/Fe_3O_4 thermite mixtures.** Hammetter, W.F. (Sandia National Labs., Albuquerque, NM (USA)). Nov 1983. Contract AC04-76DP00789. 46p. NTIS, PC A03/MF A01. Order Number DE84002990.

Stoichiometric mixtures of Al/Fe_3O_4 thermite were compacted in a range of pressures (to 281 MPa), temperatures (25° to 400°C), and times (5 to 300 min) in order to obtain a map of compact density with respect to these variables and to elucidate the densification mechanism. Different sources of Al and Fe_3O_4 were used to study the effect of particle size distribution and morphology on the densification mechanism. In general, when coarse magnitite powder is used, densification is through plastic deformation of the aluminum particles up to a temperature dependent pressure above which work hardening limits further densification. Densification is enhanced at higher temperatures and by using large (30 to 50 μm) spherical aluminum powder particles. Densification of thermite mixtures with fine (< 5 μm) magnitite powder is temperature independent and is due to mechanical interlocking of the fine magnitite particles.

5358 **(UCID—19883) Bullet/fragment explosive vulnerability test.** Honodel, C.; Lee, E. (Lawrence Livermore National Lab., CA (USA)). Sep 1983. Contract W-7405-ENG-48. 14p. NTIS, PC A02/MF A01. Order Number DE84002193.

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We have developed test fixtures and diagnostics for studying bullet/fragment attack on explosives. The principal new feature is the use of high elongation strain gauges and digital recording to obtain high resolution mechanical response. The first test series was successful. Gauge and camera records show clear differentiation of mechanical and explosive response with microsecond resolution.

5359 **(UCRL—15556) Computer simulation of two-dimensional impact tests on propellant.** Murri, W.J.; Seaman, L. (SRI International, Menlo Park, CA (USA)). Aug 1983. Contract W-7405-ENG-48. 24p. NTIS, PC A02/MF A01. Order Number DE84002460.

Computational simulations were performed of several hazards tests previously carried out by LLNL. The hazards tests consisted of side-on impacts of a propellant cylinder by a massive steel projectile with subsequent blast wave loading from an adjacent explosive charge. The simulations used a dynamic fracture model previously developed by SRI. The computational results showed that whereas the fracture-induced new surface area in the propellant is increasing with increasing impact velocity at the observed threshold impact velocity, no dramatic damage threshold is calculated in that velocity range. It is recommended that the fracture model be supplemented by algorithms that account for the increase in chemical reaction rate caused by the increase in fracture surface area and the application of pressure.

5360 **(UCRL—15557) Characterization of initiation and detonation by Lagrange gage techniques. Final report.** Cowperthwaite, M. (SRI International, Menlo Park, CA (USA)). Aug 1983. Contract W-7405-ENG-48. 23p. NTIS, PC A02/MF A01. Order Number DE84002462.

The work on reactive flow Lagrange analysis (RFLA) was concerned with Lagrange particle velocity histories that exhibit double maxima similar to those recorded in RX26 and PBX9404. Conditions for particle velocity histories to exhibit extrema were formulated in terms of envelopes formed by Lagrange pressure histories. Lagrange analysis of the flow produced by the expansion of a detonation wave at a free surface was proposed to extend the determination of the release adiabat of detonation products from the Chapman-Jouguet (CJ) state to zero pressure. Solutions were constructed for steady-state nonideal detonation waves propagating in polytropic explosive with two reacting components. Overdriven

detonation was treated both as a reactive discontinuity and as a Zeldovich-von Neumann-Doering (ZND) wave. The Rankine-Hugoniot (RH) jump conditions were used to calculate the first and second derivatives on the detonation velocity versus particle velocity Hugoniot at the CJ point. Methods of differential geometry were used to determine the conditions that allow the flow equations and RH boundary conditions to admit similarity solutions for overdriven detonation waves.

5361 **(UCRL—89845) Time resolved measurement and analysis of the response of confined explosives to heat, impact and penetration.** Von Holle, W.G.; Lee, E.; Nutt, G.; Honodel, C.; McWilliams, R. (Lawrence Livermore National Lab., CA (USA)). 24 Oct 1983. Contract W-7405-ENG-48. 22p. (CONF-8311104—1). NTIS, PC A02/MF A01. Order Number DE84002781.

From Physics of explosives technical meeting; Unterluss, F.R. Germany (2 Nov 1983).

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We have developed test fixtures and diagnostics for studying bullet/fragment attack on explosives. The principal new feature is the use of high elongation strain gauges and digital recording to obtain high resolution mechanical response. The first test series was successful. Gauge and camera records show clear differentiation of mechanical and explosive response with microsecond resolution. We have also developed a new test fixture for evaluating the violence of the thermal response of confined explosives. The fixture is designed to provide simple heat flow and relatively simple mechanical response. Comparisons between hydrodynamic calculations and experiment show quantitatively the deflagrative nature of the response. Five-nanosecond response infrared radiometers have been used in planar impact experiments to measure the radiance histories from shocked explosives. The shock heating of granular pressed explosives is resolved into two parts which we believe correspond to hot spot formulation and subsequent growth. Using this technique we have shown a strong particle size effect in the insensitive explosive TATB. 25 figures.

4502 Nuclear

REFER ALSO TO CITATION(S) 4398

5362 **(UCRL—15558) Test program for assessing vulnerability of industrial equipment to nuclear air blast. Final report.** Zaccor, J.V.; Selvaduray, G. (Scientific Service, Inc., Redwood City, CA (USA)). Sep 1983. Contract W-7405-ENG-48. 58p. NTIS, PC A04/MF A01. Order Number DE84002776.

The report discusses considerations pertinent to the design of a test program to develop technical data on the vulnerability of industrial equipment to air blast from nuclear weapons (1 megaton weapons size in the overpressure region up to 20 psi). Information is provided on the appropriate use of scale models, full size models, and actual equipment to achieve the experimental objective, and it is concluded that all three are appropriate to the program for different facets; the specific circumstances for each are identified. A procedure is identified for selecting equipment for testing, and for making technical versus economic tradeoffs in selecting a given level of vulnerability or for verifying the representativeness of a selection or tradeoff to achieve a general level of vulnerability. Damage mechanisms likely to affect equipment subjected to a blast wave are identified and a flow chart identifies test types and major parameters affecting outcome, which must be addressed in any comprehensive effort to develop data intended to isolate overpressure, drag, and missile effects. A minimum experimental program is proposed to provide reference equipment-vulnerability-data for the communications/electronics industry for four different air blast damage mechanisms as the first stage in the eventual development of data on hardening. A total of 525 separate tests are proposed, involving 186 units of four different types of equipment and 6 scale models.

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

5001 Basic Studies

REFER ALSO TO CITATION(S) 5094

5002 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 4333

5363 **(CONF-820317—2) Assessment of emissions from a hazardous waste incineration facility.** Staley, L.J.; Holton, G.A.; O'Donnell, F.R.; Little, C.A. (Oak Ridge National Lab., TN (USA); Environmental Protection Agency, Cincinnati, OH (USA). Industrial Environmental Research Lab.). 1982. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE84003408.

From 8. annual research symposium on solid and hazardous waste; Cincinnati, OH, USA (8 Mar 1982).

The exposure in a nearby population to volatile organic compounds (VOCs) from emissions of a municipal hazardous waste incinerator is determined by measuring the emission rates and estimating the dispersion of those pollutants over the surrounding community. Measurements of fugitive VOC emissions from leaky pipe fittings, flanges, pumps, and valves are made. VOC emissions from the stack and air pollution control devices are also measured. An emission assessment is then performed to determine the percentage concentration and population exposure associated with selected emissions from each source at the facility. Results indicate that, in this particular case, fugitive and stack emissions do not contribute significantly to pollutant concentration and population exposure. Further, data for specific constituents of the VOC emissions also show extremely low concentrations and exposure, but these results are based on only a partial analysis and additional qualitative emission analyses are required. 8 references, 2 figures, 4 tables.

5364 **(CONF-830671—2) Gas exchange measurements in natural systems.** Broecker, W.S.; Peng, T.H. (Oak Ridge National Lab., TN (USA); Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). 1983. Contract W-7405-ENG-26. 32p. NTIS, PC A03/MF A01. Order Number DE84003166.

From International symposium on gas transfer at water surface; Ithaca, NY, USA (13 Jun 1983).

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Direct knowledge of the rates of gas exchange in lakes and the ocean is based almost entirely on measurements of the isotopes ^{14}C, ^{222}Rn and ^{3}He. The distribution of natural radiocarbon has yielded the average rate of CO_2 exchange for the ocean and for several closed basin lakes. That of bomb produced radiocarbon has been used in the same systems. The ^{222}Rn to ^{226}Ra ratio in open ocean surface water has been used to give local short term gas exchange rates. The radon method generally cannot be used in lakes, rivers, estuaries or shelf areas because of the input of radon from sediments. A few attempts have been made to use the excess ^{3}He produced by decay of bomb produced tritium in lakes to give gas transfer rates. The uncertainty in the molecular diffusivity of helium and in the diffusivity dependence of the rate of gas transfer holds back the application of this method. A few attempts have been made to enrich the surface waters of small lakes with ^{226}Ra and ^{3}H in order to allow the use of the ^{222}Rn and ^{3}He methods. While these studies give broadly concordant results, many questions remain unanswered. The wind velocity dependence of gas exchange rate has yet to be established in field studies. The dependence of gas exchange rate on molecular diffusivity also remains in limbo. Finally, the degree of enhancement of CO_2 exchange through chemical reactions has been only partially explored. 49 references, 2 figures, 2 tables.

5365 **(DOE/ER—0178) Carbon dioxide research plan. A summary.** (USDOE Office of Energy Research, Washington, DC. Office of Basic Energy Sciences). Nov 1983. 37p. NTIS, PC A03/MF A01. Order Number DE84002963.

The Department of Energy is the lead federal agency for research related to atmospheric carbon dioxide. Its responsibility is to sponsor a program of relevant research, and to coordinate this research with that of others. As part of its responsibilities, the Department of Energy has prepared a research plan. The plan documented in this Summary delineated the logic, objectives, organization, background and current status of the research activities. The Summary Plan is based on research subplans in four specific areas: global carbon cycle, climate effects, vegetative response and indirect effects. These subplans have emanated from a series of national and international workshops, conferences, and from technical reports. The plans have been peer reviewed by experts in the relevant scientific fields. Their execution is being coordinated between the responsible federal and international government agencies and the involved scientific community.

5366 **(DOE/ET/03425—23/24) Balance of the tropospheric ozone and its relation to stratospheric intrusions indicated by cosmogenic radionuclides. Part IX and Part X. Combined annual report, 1 November 1977-31 October 1979.** Reiter, R.; Kanter, H.J.; Jaeger, H.; Munzert, K. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Garmisch-Partenkirchen (Germany, F.R.). Inst. fuer Atmosphaerische Umweltforschung). Aug 1983. Contract AC02-76EV03425. 72p. NTIS, PC A04/MF A01. Order Number DE84002885.

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The dependence of the tropospheric ozone on meteorological parameters, anthropogenic, and natural atmospheric pollution was investigated. Using continuous measuring series obtained in the years 1977/78 at three different levels (Zugspitze 3.0 km ASL, Wank, 1.8 km ASL, and Garmisch, 700 m ASL) the frequency of occurrence of ozone concentrations $>$ 70 ppB has been determined. Through correlation with tracers Be7 (for stratospheric origin) and radon decay products (for tropospheric origin) the question of possible sources was examined. Stratospheric ozone can be documented in individual cases. PHotochemically-produced ozone is largely confined to the ground layer and leads there relatively frequently to concentrations $>$ 70 ppB. The continuous CO_2-recordings at the stations Wank and Garmisch have been started during the reporting period. Lidar observations of the stratospheric aerosol show low, almost constant values of the backscattering ratio. From those it can be concluded that after a relatively long period of low volcanic activity the stratospheric aerosol is in a quasi-stationary state that corresponds to natural background conditions. 25 references, 22 figures, 24 tables.

5367 **(TENRAC/EDF—100-Vol.1) Chemical composition of acid precipitation in Texas. Vol. 1. Final report.** Liljestrand, H.M. (Texas Univ., Austin (USA). Center for Energy Studies). 31 Aug 1983. 309p. NTIS, PC A14/MF A01. Order Number DE84900411.

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A two year study of acid deposition has been conducted in Texas. Rainwater samples were collected in Austin, Prairie View, Highlands (East Houston), Houston (West), Dallas, College Station and Tyler. Constituents analyzed included the major cations (pH, ammonium, sodium, potassium, calcium, and magnesium), major anions (chloride, nitrate, sulfate, bicarbonate, fluoride, bromide, and phosphate), trace species (total organic carbon, formaldehyde, manganese, lead, total Kjeldahl nitrogen, and conductivity). A summary of the present acid precipitation composition in Texas as determined by this study is presented, along with a comparison with the data reported before 1980, which indicated less acidity in Texas precipitation. Also presented are a list of specific conclusions from the study and the areas requiring further research. Moreover, a summary of anticipated impact of projected acid precursor emissions from lignite coal development is also presented. Careful consideration of additional NO/sub X/ and SO_2 emissions in east Texas should be made, since the natural background alkalinity from ammonia and soil dust is insufficient to buffer the present acid contributions in east Texas. 122 references, 190 figures, 98 tables.

5368 **(TENRAC/EDF—100-Vol.2) Chemical composition of acid precipitation in Texas. Volume 2. Final report.** Liljestrand, H.M. (Texas Univ., Austin (USA). Center for Energy Studies). Aug 1983. 444p. NTIS, PC A19/MF A01. Order Number DE84900415.

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A two year study of acid deposition has been conducted in Texas. Rainwater samples were collected in Austin, Prairie View, Highlands (East Houston), Houston (West), Dallas, College Station and Tyler. Constituents analyzed included the major cations (pH, ammonium, sodium, potassium, calcium, and magnesium), major anions (chloride, nitrate, sulfate, bicarbonate, fluoride, bromide, and phosphate), trace species (total organic carbon, formaldehyde, manganese, lead, total Kjeldahl nitrogen, and conductivity). A summary of the present acid precipitation composition in Texas as determined by this study is presented, along with a comparison with the data reported before 1980, which indicated less acidity in Texas precipitation. Also presented are a list of specific conclusions from the study and the areas requiring further research. Moreover, a summary of anticipated impact of projected acid precusor emissions from lignite coal development is also presented. Careful consideration of additional NO/sub x/ and SO_2 emissions in east Texas should be made, since the natural background alkalinity from ammonia and soil dust is insufficient to buffer the present acid contributions in east Texas. 122 references, 190 figures, 98 tables.

5003 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 4336, 5366

5369 **(CONF-831047—110) Establishing release limits for ^{3}H, ^{14}C, ^{85}Kr, and ^{129}I.** Kocher, D.C.; Killough, G.G. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01. Order Number DE84003279.

From American Nuclear Society winter meeting; San Francisco, CA, USA (30 Oct 1983).

Tritium (^{3}H), ^{14}C, ^{85}Kr, and ^{129}I are the most important globally dispersed radionuclides released from the nuclear fuel cycle. In this paper, we investigate whether global transport of these radionuclides could also be important in assessing doses to individuals in critical groups of the population.

5370 **(DOE/EV/13573—3) Fate of nuclides in natural water systems. Annual progress report, April 1, 1983-March 31, 1984.** Turekian, K.K. (Yale Univ., New Haven, CT (USA). Dept. of Geology and Geophysics). 30 Nov 1983. Contract AC02-76EV13573. 21p. NTIS, PC A02/MF A01. Order Number DE84002948.

This study of the behavior of nuclides in natural water systems is divided into studies of atmospheric aerosols, soils, groundwater, rivers, estuaries and coastal zones, the carbon cycle and the growth rates of marine organisms.

5371 **(DP—1672) Environmental aspects of a tritium release from the Savannah River Plant on July 16, 1983.** Garrett, A.J.; Zeigler, C.C.; Carver, D.R.; Stevenson, D.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Oct 1983. Contract AC09-76SR00001. 46p. NTIS, PC A03/MF A01. Order Number DE84003662.

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The environmental impact of tritium release from the Savannah River Plant was assessed by using both predictive and measurement techniques. Predictions of the onsite and offsite consequences by the WIND emergency response system agreed closely with results determined from environmental samples. The maximum radiation dose to a hypothetical individual at the SRP boundary as a result of this release was calculated to be 0.04 mrem. The maximum dose observed by urinalysis of offsite individuals in the release trajectory was 0.034 mrem. The 0.04 mrem dose corresponds to 0.02% of the dose that persons who live in the vicinity of SRP receive annually from natural radiation and from medical and miscellaneous radiation sources. 10 references, 9 figures, 4 tables.

5372 **(INIS-mf—8469) Environmental monitoring of nuclear facilities. General aspects and practical work at the Karlsruhe Nuclear Research Center.** Papadopoulos, D.; Winter, M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). 1982. 31p. (CONF-8209134—3). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703291.

From IAEA interregional training course on waste management in nuclear facilities; Karlsruhe, F.R. Germany (6 Sep 1982).

Environmental monitoring adds to the control of emissions of radioactive substances from nuclear facilities. The radioactive substances released with the exhaust air and the liquid effluent result in impact levels in the immediate vicinity, which must be ascertained by measurement. Impact control serves for the quantitative assessment of man-made radioactivity in different media of relevant pathways and for the direct assessment of the radiation exposure of the public living in the vicinity. In this way, the radiation exposure of the environment, which can be calculated if the emission data and the meteorological diffusion parameters are known, is controlled directly.

5373 **(LBL—16636) Characterizing the source of radon indoors.** Nero, A.V.; Nazaroff, W.W. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 47p. (CONF-831049—1). NTIS, PC A03/MF A01. Order Number DE84002928.

From International seminar on indoor exposure to natural radiation and related risk assessment; Capri, Italy (3 Oct 1983).

Average indoor radon concentrations range over more than two orders of magnitude, largely because of variability in the rate at which radon enters from building materials, soil, and water supplies. Determining the indoor source magnitude requires knowledge of the generation of radon in source materials, its movement within materials by diffusion and convection, and the means of its entry into buildings. This paper reviews the state of understanding of indoor radon sources and transport. Our understanding of generation rates in and movement through building materials is relatively complete and indicates that, except for materials with unusually high radionuclide contents, these sources can account for observed indoor radon concentrations only at the low end of the range observed. Our understanding of how radon enters buildings from surrounding soil is poorer, however recent experimental and theoretical studies suggest that soil may be the predominant source in many cases where the indoor radon concentration is high. 73 references, 3 figures, 1 table.

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

5101 Basic Studies

REFER ALSO TO CITATION(S) 5405

5374 **(ORNL/CSD/TM—206) Appalachian oak model for simulating primary production.** Mankin, J.B.; Risser, P.G. (Oak Ridge National Lab., TN (USA); Illinois Natural History Survey, Urbana (USA)). Nov 1983. Contract W-7405-ENG-26. 169p. NTIS, PC A08/MF A01. Order Number DE84003497.

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A simulation model of overstory and understory woody plant production in Appalachian oak-hickory forests was developed for the purpose of simulating plant production over a large spatial scale using readily available data. This model is intended to be sufficiently accurate to aid in decisions of a resource management nature and to be sufficiently simple to be clearly understood by resource managers. Model estimates of primary production were equivalent to field data from the Walker Branch watershed at Oak Ridge National Laboratory and from a hardwood watershed at the Cowetta Hydrologic Laboratory. The model predicted more woody tissue and less foliage tissue than would be inferred from observational data; however, there are few field studies available for comparison with model predictions. Overstory thinning experiments were imposed on the model and a number of predicted responses were considered. Thinning was imposed during the first year of simulation, and model predictions were based on the following two years. Low levels of thinning of the hardwood forest (10 and 30%) had little effect on the overstory, but severe thinning (70 and 90%) drastically reduced the predicted amounts of total overstory primary production and amounts of foliage, bole, roots and storage (labile carbohydrates). Thinning caused increases in virtually all understory components, with foliage and roots showing a more rapid response than understory boles. Simulated thinning experiments in the pitch pine forest demonstrated an increase in understory plant production, but the response was not as great as in the hardwood forest. 19 references, 53 figures, 7 tables.

5102 Chemicals Monitoring And Transport

5375 **(CONF-821144—3) Effects of acid rain on forest soil change.** Richter, D.D.; Johnson, D.W. (Oak Ridge National Lab., TN (USA)). 1982. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01. Order Number DE84003367.

From APCA specialty conference on atmospheric deposition; Detroit, MI, USA (7 Nov 1982).

Studies in east Tennessee of three forest soils currently classified as sensitive to acid rain have indicated that acid deposition is unlikely to significantly acidify these soils or deplete base cations. The purpose of this report is to contend that these conclusions may apply to other forest-soil systems as well. There is evidence from a variety of studies to indicate that in general, soil properties and pedogenic processes exert strong control over acidity of forest soils and soil solutions, independently of precipitation pH. Natural sources and sinks of acidity appear to be large, and soil organic matter and minerals buffer soil systems such that reductions in atmospheric H^+-ion deposition are unlikely to alter greatly the acidity of soils or soil solutions. 43 references, 3 figures, 3 tables.

5376 **(INIS-BR—14) Effects of cultivation on the organic matter of total soil and in the different soil particle size separates using radiocarbon dating.** Gazineu, M.H.P. (Pernambuco Univ., Recife (Brazil). Dept. de Energia Nuclear). Jul 1982. 103p. (In Portuguese). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83703266.

Thesis (Ph.D.).

The effects of cultivation on the organic matter and nutrients in the total soil and in five particle size separates were studied through chemical analyses and radiocarbon dating. Samples were taken from the A and B horizons of an uncultivated field and of fields cultivated during 5,60 and 90 years which had never received treatment with fertilizers.

5377 **(ORNL/TM—8865) Use of electromagnetic terrain conductivity measurements to map liquid hazardous waste migration in groundwater.** Ketelle, R.H.; Pin, F.G. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01. Order Number DE84002992.

Electromagnetic conductivity measurements have been used to map apparent ground conductivity in the vicinity of a liquid hazardous waste disposal site. An area of approximately 12 ha (30 acres) was surveyed. Approximately 600 conductivity measurements were obtained to prepare a conductivity map of the site. Conductivity measurments in the area correlate with specific conductance measurements of surface and groundwater samples. Contouring of the conductivity data showed the precise location of contaminant migration pathways in the subsurface. A complex contaminant plume was defined by the conductivity survey. Conductivity values obtained reflected anisotropic characteristics related to local bedrock structure. Anisotropy characteristics and the use of different instrument configurations indicated semiquantitatively the depth of the high conductivity zone and the direction of flow.

5378 **(ORNL-tr—5051) Site-related studies of silver-fir disease: mineral content distribution in silver-fir (Abies alba Mill.) roots, and its dependence on tree vigor and on soil properties.** Reiter, H.; Alcubilla, M.; Rehfuess, K.E. Translated from *Allgemeine Forst- und Jagdzeitung ;* **154**: 82-92(1983). Contract W-7405-ENG-26. 26p. NTIS, PC A03/MF A01. Order Number DE84002549.

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On three different sites in Bavaria the root systems of five 90 to 110 years old silver fir trees (Abies alba MILL.) were investigated at a standardized profile wall. We examined both the morphological properties and the mineral nutrient contents of the roots as well as the pH and the cation exchange characteristics of the corresponding soil layers. Sample trees were a healthy fir in the FoA Starnberg (Parabraunerde derived from glacial outwash, E) and a healthy and an affected fir in both the study areas at Kelheim (gray brown podzolic soil derived from loess, B) and Freyung (podzolic brown forest soil derived from granite, C). The investigations aimed to demonstrate possible relations between damages of the roots, soil properties and silver fir decline. More over they should deliver evidence, whether mobile Al and Mn in the soil are damaging the root systems. There is evidence that diseased silver fir trees have a less developed root system as compared with apparently healthy neighbours on the same soil. The differences observed, however, are smaller than expected. Neither an earlier investigation in the same sample stands using foliage and phloem analysis nor the present approach were able to document toxic effects of Al or heavy metals in the study area. 20 references, 6 figures, 8 tables.

5103 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 4336, 4442, 4483, 5370

5379 **(CONF-830610—2) Characterization of Pu-contaminated soils from Nuclear Site 201 at the Nevada Test Site.** Lee, S.Y.; Tamura, T.; Larsen, I.L. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01. Order Number DE84003176.

From Nevada Applied Ecology Group transuranics (and associated radionuclides) information conference; Las Vegas, NV, USA (28 Jun 1983).

Distribution and characteristics of Pu-bearing radioactive particles throughout five soil profiles from Nuclear Site (NS) 201 were investigated. Concentrations of ^{239,240}Pu and ^{241}Am decreased with depth and most of the contamination was contained in the top 5 cm except in profile 4 where it extended to 10 cm. The mean activity ratio of ^{239,240}Pu to ^{241}Am and its standard error were 5.8 +- 0.3 (N=42). Most of the total radioactivity of the soils was contributed by 0.25 to 2 mm sand size fraction which comprised 20 to 50% by weight of the soils. The radioactive particles in the 0.25 to 2 mm size fraction occurred as spherical glass particles or as glass coatings on sand particles. The glass coatings had gas voids in the matrix but were not as porous as the radioactive particles from NS 219. After impact grinding the >0.25-mm size fractions for one hour, 85% of the initial activity in a NS 201 sample remained with the particles on the 0.25 mm sieve, whereas in the NS 219 sample only 10% remained. The results show that the radioactive particles from NS 201 were much more stable against the impact grinding force than those from NS 219. Therefore, the NS 201 soils would be expected to have a lower probability of producing respirable-size radioactive particles by saltation during wind erosion. 19 references, 3 figures, 3 tables.

5105 Site Resource And Use Studies

5380 **(N—8326163) Image analysis for facility siting: A comparison of low and high-altitude image interpretability for land use/land cover mapping.** Borella, H.M.; Estes, J.E.; Ezra, C.E.; Scepan, J.; Tinney, L.R. (California Univ., Santa Barbara (USA)). 1982. 25p. NTIS, PC A14/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 1 p 97-121 (SEE N83-26155 15-43).

For two test sites in Pennsylvania the interpretability of commercially acquired low-altitude and existing high-altitude aerial photography are documented in terms of time, costs, and accuracy for Anderson Level II land use/land cover mapping. Information extracted from the imagery is to be used in the evaluation process for siting energy facilities. Land use/land cover maps were drawn at 1:24,000 scale using commercially flown color infrared photography obtained from the United States Geological Surveys' EROS Data Center. Detailed accuracy assessment of the maps generated by manual image analysis was accomplished employing a stratified unaligned adequate class representation. Both 'area-weighted' and 'by-class' accuracies were documented and field-verified. A discrepancy map was also drawn to illustrate differences in classifications between the two map scales. Results show that the 1:24,000 scale map set was more accurate (99% to 94% area-weighted) than the 1:62,500 scale set, especially when sampled by class (96% to 66%). The 1:24,000 scale maps were also more time-consuming and costly to produce, due mainly to higher image acquisition costs.

5381 **(N—8326188) A temporal approach to monitor surface mine reclamation progress via LANDSAT.** Davis, A.L.; Bloemer, H.L.; Brumfield, J.O. (Ohio Univ., Athens (USA)). 1982. 16p. NTIS, PC A18/MF A01.

In Proc. of the Natl. Conf. on Energy Resource Management, Vol. 2 p 457-462 (SEE N83-26176 15-43).

Using LANDSAT satellite imagery, the mine reclamation process can be studied on a temporal and continuing basis. Not only can the progress of reclamation be readily monitored, but also a breakdown in the mining reclamation process can be detected. In viewing reclamation, it is important to monitor the mined site well past initial revegation stages. With present mining law and bonding procedures, fast revegetational growth is encouraged, often leading to poor soil fertilizing and inappropriate stabilizing species. As a result, the initial reclamation may exhibit good qualities for one or two years but then may experience vegetational deterioration after the state has relinquished the mining company from it's responsibility. It is this small-scale breakdown in the reclamation process that was detected using an unsupervised classification technique with eight-year temporal LANDSAT imagery coverage.

52 ENVIRONMENTAL SCIENCES, AQUATIC

5201 Basic Studies

REFER ALSO TO CITATION(S) 5094

5382 **Feeding behavior of large calanoid copepods Neocalanus cristatus and N. plumchrus from the subarctic Pacific Ocean.** Frost, B.W.; Hassett, R.P.; Landry, M.R. (School of Oceanography, WB-10, University of Washington, Seattle, WA 98195). *Deep-Sea Research, Part A: Oceanographic Research Papers;* **30**: No. 1A, 1-14(Jan 1983).

Oceanic waters of the subarctic Pacific exhibit a special ecological feature; a virtually seasonally invariant standing stock of phytoplankton (measured as chlorophyll a), that seems to reflect a balance, at least during spring and summer, between phytoplankton growth and zooplankton grazing. The grazers presumed to be responsible for the balance are the calanoid copepods Neocalanus cristatus and N. plumchrus. Shipboard grazing experiments, utilizing both natural suspended particulate material and cultured phytoplankton as food for the copepods, showed that both species have at least three attributes of feeding behavior required to maintain a steady standing stock of phytoplankton. That is, the Neocalanus species can feed at the low concentrations of phytoplankton that prevail in the open subarctic Pacific, they feed at a similar rate on a broad range of particle sizes including the predominant particles, and they respond to small increases in phytoplankton concentration by proportionately larger increases in their feeding rate. Although both species of Neocalanus attain larger body sizes than co-occurring Calanus pacificus and Pseudocalanus sp., they have morphological specializations that seem to account for their unexpected ability to feed on very dilute suspensions of small phytoplankton cells. It appears tha the perpetually low phytoplankton concentrations in the open subarctic Pacific do not permit maximum feeding effort by the species of Neocalanus.

5202 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 5364

5383 (INIS-BR—12) Levels of chromium contamination in the estuary of the Iraja river (Guanabara Bay) and experimental incorporation of ^{51}Cr in barnacles (Balanus sp). Weerelt, M.D.M.V. (Rio de Janeiro Univ. (Brazil). Inst. de Biofisica). 1982. 99p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83703271.

Thesis (Ph.D.).

Levels were determined of chromium contamination in the estuary of Iraja River, produced by an electroplating industry located 3 km upstream the study area. Uptake-and release kinetics of Cr(VI) and Cr(III) in barnacles (Balanus sp.) were studied. Samples of barnacles and suspended particles from Guanabara Bay were analysed. Chromium concentrations (dry weight) ranged from not detectable (ND) to 154,66 $\mu g/g$ for soft tissues and from ND to 423,76 $\mu g/g$ for suspended particles. Mean of maximum concentrations of chromium in samples from Guanabara Bay are 3 and 4 times above those of identical samples from control area (Coroa Grande). Soft tissues presented a concentration factor (CF) of 10^3 related to chromium available in suspended particles. $^{51}Cr(VI)$ is preferentiably incorparated by soft tissues (biological half life being 100 days). Chromium uptake by Balanus sp from solution is as significant as it is from particulate matter available in sea water from experimental sets. CF for Cr(VI) in soft tissues in laboratory conditions was 10^2 related to ^{51}Cr present in sea water. Environmental chromium contamination was found to be of the same order of magnitude or above levels reported for other areas subjected to industrial impacts. Barnacles appear to be able to accumulate chromium in soft tissues from the available metal in the environment. Cr(VI) is the critical form, being greatly accumulated in soft tissues of barnacles, that act as a long-term integrator of this metal. For Cr(III), this organism can only be regarded as an instantaneous indicator of environmental contamination of chromium attached to suspended particles.

5384 (TVA/PUB—84/7) Potential ground-water quality impacts at TVA steam plants. Harris, W.F.; Foxx, M.S. (Tennessee Valley Authority, Norris (USA). Office of Natural Resources). Sep 1982. 91p. NTIS, PC A05/MF A01. Order Number DE84900347.

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This report describes an assessment of the potential for adverse impacts on the ground-water quality from waste disposal facilities at the 12 TVA fossil-fuel steam plants. This assessment is based upon a reconnaissance-level study conducted in 1981. The basic data utilized include plant operations, site geology and geohydrology, ground-water use, and the regional ground-water quality at each plant. This information is brought together in this report to serve as a reference document. The assessments made in this report are based primarily upon the ground-water gradient at each steam plant. Site-specific ground-water quality data are available at two TVA steam plants, Kingston and Widows Creek. These data indicate that if leachate from TVA disposal facilities were to migrate offsite, the ground water in these areas could be adversely impacted. Therefore, this study focuses on the potential for offsite, the ground water in these areas could be adversely impacted. Therefore, this study focuses on the potential for offsite migration of leachate where the potential for adverse impacts to a usable ground-water resource exists. The primary finding from this reconnaissance-level study is that no major adverse impacts to the ground-water resource outside reservation boundaries appear to be resulting from the waste disposal facilities at the 12 TVA steam plants. 45 references, 26 figures.

5203 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 4336, 4482, 4710, 5370, 5372

5385 (CONF-821076—2) Transport of fallout and reactor radionuclides in the drainage basin of the Hudson River estuary. Simpson, H.J.; Linsalata, P.; Olsen, C.R. (Oak Ridge National Lab., TN (USA); Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory; New York Univ., NY (USA). Inst. of Environmental Medicine). 1982. Contract W-7405-ENG-26. 54p. NTIS, PC A04/MF A01. Order Number DE84003324.

From Southeastern TIMS meeting; Myrtle Beach, SC, USA (7 Oct 1982).

The transport and fate of Strontium 90, Cesium 137 and Plutonium 239, 240 in the Hudson River Estuary is discussed. Rates of radionuclide deposition and accumulation over time and space are calculated for the Hudson River watershed, estuary, and continental shelf offshore. 37 references, 7 figures, 15 tables. (ACR)

5386 (UCID—19924) Radionuclides in sediments from the northeast Atlantic disposal site. Noshkin, V.E.; Wong, K.M.; Eagle, R.J. (Lawrence Livermore National Lab., CA (USA)). Nov 1983. Contract W-7405-ENG-48. 15p. NTIS, PC A02/MF A01. Order Number DE84003337.

The concentrations and inventories of $^{239+240}Pu$ in sediments from within the boundaries of the low-level radioactive waste-disposal site in the northeast Atlantic are not significantly different from global fallout levels expected in deep-sea sediments from this region of the Atlantic. No man-made gamma-emitting radionuclides were above detection limits in the sediment samples analyzed. Further, there is no indication that past disposal practices have led to an area-wide contamination of the site with waste-related radionuclides. 3 references, 2 figures.

5204 Thermal Effluents Monitoring And Transport

5387 (TVA/ONR/WRF—83/15(a)) Responses of selected aquatic biota to thermal discharges from Cumberland Steam-Electric Plant: Barkley Reservoir, Tennessee, 1978 and 1979. Craven, T.M.; Dycus, D.L.; Wade, D.C. (Tennessee Valley Authority, Knoxville (USA). Office of Natural Resources). Aug 1983. 125p. NTIS, PC A06/MF A01. Order Number DE84900349.

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The extent and degree of exposure of aquatic biota to the thermal plume from Cumberland Steam-Electric Plant (CUF) depends upon several factors, including temperature and volume of water discharged from the plant into the Cumberland River and river flow rates. During periods of discharging large volumes of heated water (maximum plant operation) to the Cumberland River under low flow conditions, maximum exposure would occur, influencing aquatic biota both up- and downstream of the plant. Results of this study, made during periods of maximum potential thermal stress (July to September) under varying flow and reservoir conditions, show thermal discharges from TVA's Cumberland Plant are not adversely impacting local aquatic communities studied. Differences in population structures and standing crops of plankton and macroinvertebrates were more related to reservoir conditions (i.e., suspended solids) than to operation of the plant. Community numbers and indices of health (as measured) downstream of the plant were usually as high as or higher than in upstream (unaffected) areas. Although several isolated effects occurred immediately downstream of the thermal discharge, no permanent alterations were documented on the local Cumberland River floral and faunal communities. 101 references, 25 figures, 24 tables.

5388 (TVA/ONR/WRF—83/15(b)) Responses of selected aquatic biota to thermal discharges from Cumberland Steam-Electric Plant: Barkley Reservoir, Tennessee, 1978 and 1979. Appendices. Craven, T.M.; Dycus, D.L.; Wade, D.C. (Tennessee Valley Authority, Knoxville (USA). Office of Natural Resources). Aug 1983. 459p. NTIS, PC A20/MF A01. Order Number DE84900348.

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The extent and degree of exposure of aquatic biota to the thermal plume from Cumberland Steam-Electric Plant (CUF) depends upon several factors, including temperature and volume of water discharged from the plant into the Cumberland River and river flow rates. During periods of discharging large volumes of heated water (maximum plant operation) to the Cumberland River under low flow conditions, maximum exposure would occur, influencing aquatic biota both up- and downstream of the plant. Results of this study, made during periods of maximum potential thermal stress (July to September) under varying flow and reservoir conditions, show thermal discharges from TVA's Cumberland Plant are not adversely impacting local aquatic communities studied. Differences in population structures and standing crops of plankton and macroinvertebrates were more related to reservoir conditions (i.e., suspended solids) than to operation of the plant. Community numbers and indices of health (as measured) downstream of the plant were usually as high as or higher than in upstream (unaffected) areas. Although several isolated effects occurred immediately downstream of the thermal discharge, no permanent alterations were documented on the local Cumberland River floral and faunal communities. This volume contains data on water quality, temperatures, river flow, plankton composition and biomass, and macrophyte species.

5205 Site Resource And Use Studies

5389 (TVA/ONR/WR—83/7) Trophic status evaluation of TVA reservoirs. Placke, J.F. (Tennessee Valley Authority, Chattanooga (USA). Div. of Water Resources). Oct 1983. 170p. NTIS, PC A08/MF A01. Order Number DE84900364.

Portions are illegible in microfiche products.

TVA tributary and mainstem reservoirs show generalized differences in morphometry, hydraulics, nutrient loads, and response to nutrient concentrations. Neither type of reservoir is strictly comparable to the natural lakes on which classical eutrophication studies have been based. The majority of published trophic state indices and standards (e.g., hypolimnetic dissolved oxygen depletion, Secchi depth, areas nutrient loading rates, in-reservoir phosphorus concentrations) are inappropriate for evaluation of some or all TVA reservoirs. No single trophic potential or trophic response variable summarizes the mechanisms and manifestations of eutrophication sufficiently to be used as a sole criterion for judging or regulating TVA reservoir water quality. Relative multivariate trophic state indices were developed for mainstem and tributary reservoirs. Ranking of the mainstem reservoirs is based on chlorophyll, macrophyte coverage, hydraulic retention time, reservoir area less than five feet deep, annual pool elevation drawdown, and Secchi depth. Based on available data, the rank from least eutrophic to most eutrophic is: Pickwick, Kentucky, Chickamauga, Nickajack, Wilson, Fort Loudoun, Watts Bar, Wheeler, and Guntersville Reservoirs. Ranking of the tributary reservoirs is based on chlorophyll, total phosphorus and total nitrogen weighted by the N:P ratio, and bioavailable inorganic carbon levels. The rank from least eutrophic to most eutrophic is: Hiwassee, Blue Ridge, Chatuge, Norris and Fontana, Watauga, South Holston, Tims Ford, Cherokee, Douglas, and Boone Reservoirs. 130 references, 18 figures, 30 tables.

5390 (TVA/ONR/WRF—83/19) Biological assessment of proposed US Army Corps of Engineers navigation dredging and disposal on freshwater mussels at sites downstream from Cordell Hull Dam, Cumberland River miles 303.8 to 309.2. Jenkinson, J.J.; Hickman, G.D. (Tennessee Valley Authority, Knoxville (USA). Office of Natural Resources and Economic Development). Oct 1983. 18p. NTIS, PC A02/MF A01. Order Number DE84900358.

Preimpoundment survey data indicate that at least four freshwater mussel species now listed as endangered by the US Fish and Wildlife Service (Dromus dromas, Lampsilis orbiculata, Plethobasus cooperianus and Pleurobema plenum) once occurred in or near CRM 303 to 309. Post impoundment surveys, including this study, indicate the L. orbiculata is widespread but uncommon throughout at least a 40 mile reach of the upper Cumberland River while the other three species persist only as rare old individuals. This survey of potential dredge, disposal and adjacent sites in CRM 305.8 to 309.1 indicated that the mussel fauna consisted of 22 species and was not particularly abundant. Lampsilis orbiculata was found to occur in proposed dredge sites at CRM 305.3, 306.5 and 307.0. The diversity and density of other species at CRM 305.5 suggested that L. orbiculata also may occur at that proposed dredge site. The single potential disposal site where L. orbiculata was found is located at CRM 305.1 to .5. Pleurobema plenum was found only at the proposed dredge site at CRM 307.0. Extensive habitat modification at any of the five dredge or disposal sites where endangered species were found or suspected, could be expected to eliminate resident specimens. Loss of L. orbiculata specimens at these sites would not constitute a substantial impact to the species throughout its range or in this reach of the Cumberland River. Loss of P. plenum at CRM 307.0 would eliminate a few of the surviving specimens of this species in the river. 10 references, 2 figures, 4 tables.

5206 Regulations

REFER ALSO TO CITATION(S) 4618

5391 (ANL/EES-TM—234) Water-quality significance of zero-discharge requirements for energy industry. Davis, M.J.; Doctor, R.D. (Argonne National Lab., IL (USA)). Mar 1982. Contract W-31-109-ENG-38. 102p. NTIS, PC A06/MF A01. Order Number DE84003660.

The US Environmental Protection Agency (EPA) has proposed standards of performance that prohibit the discharge of pollutants from specific waste streams associated with new coal-mining activity (process water from coal preparation plants) and new steam-electric power plants (fly-ash handling water) and that prohibit all discharges from new refineries. The proposed standards for zero discharge are based on practices used at some existing facilities, demonstrated technology, and cost considerations and are consistent with the requirements of the Clean Water Act. However, the expected improvement in receiving water quality that will result from zero-discharge requirements is uncertain. This report examines the water-quality significance of the proposed requirements for no discharge from new energy-sector facilities. Two approaches are applied to assess the surface-water-quality significance of requirements for no aqueous discharges from energy industries. In the first, the concentrations of pollutants in waste streams for which no discharge is proposed are compared with criteria for drinking water and freshwater aquatic life. Concentrations of pollutants following dilution in typical receiving waters are also compared with criteria. The purpose of the analysis is to examine the possibility for water quality problems near the point of discharge. The second approach considers the potential for regional, cumulative effects downstream from many facilities and how proposed requirements for no discharge might influence such regional effects. The Ohio and Missouri river basins are used in this second approach, which involves a comparison of existing transport of trace elements in the rivers with estimated trace element loads resulting from projected levels of activity in the basins, with and without zero-discharge requirements for new sources. 6 references, 10 figures, 50 tables.

53 ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

5301 Social And Economic Studies

5392 (DOE/AD/11260—T1) Results of a comparative study of the patterns of energy consumption in the Greater Miami Valley region of Ohio. Final report. (Wilberforce Univ., OH (USA)). 1979. Contract FG01-81AD11260. 98p. NTIS, PC A05/MF A01. Order Number DE84002233.

When the high, and rising, cost of energy is assessed in its economic and social impact upon residents of the Greater Miami Valley region of Ohio, the picture which emerges is not reassuring. The sample of seven hundred respondents viewed as a whole, or divided into the three ethnic group samples that comprise it, display pronounced economic and social effects. The impact ranges all

the way, for the overall group, from extreme pessimism about the future - a pessimism in which a disastrous war is forseen as a probability and in which there is no escape from perpetually increasing energy costs or a falling standard of living. This negative outlook is further accentuated by a cynicism regarding the true intentions of the energy companies, the government and the society in general.

5393 **(TENRAC/EDF—110-Vol.2) Economic implications of substituting plant oils for diesel fuel. Volume 2. Final report.** Griffin, R.C.; Collins, G.S.; Lacewell, R.D.; Chang, H.C. (Texas A and M Univ., College Station (USA). Dept. of Agricultural Economics). Aug 1983. 61p. NTIS, PC A04/MF A01. Order Number DE84900428.

This study of expected economic impacts of substituting plant oils for diesel fuel consisted of two components: (1) analysis of oilseed production and oilseed crushing capacity in the US and Texas and (2) simulation of impacts on US cropping patterns, crop prices, producer rent, and consumer surplus. The primary oilseed crops considered were soybeans, cottonseed, sunflowers, and peanuts. 19 references, 2 figures, 14 tables.

5302 Assessment Of Energy Technologies

REFER ALSO TO CITATION(S) 4790

5394 **(TENRAC/EDF—089) Examination of the environmental effects of salt-gradient solar ponds in the Red River Basin of Texas. Final report.** Dickson, K.L.; Yates, B.C. (North Texas State Univ., Denton (USA). Inst. of Applied Sciences). 28 Feb 1983. 221p. NTIS, PC A10/MF A01. Order Number DE84900420.

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Key environmental parameters involved in salt-gradient solar pond technology that should be considered for optimum siting, design, construction, operation, and maintenance procedures are identified. First, a comprehensive description of the Red River Basin is presented, which highlights those aspects of the environental setting usually covered in environmental impact statements. Negative and positive impacts of solar ponds are examined from two points of view: (1) quality environmental elements in the basin that could be affected by extensive installation of solar ponds, and (2) elements in the natural setting that could affect pond performance. Analysis of these impacts and mitigation efforts suggested in the literature are discussed. Research needs and design uncertainties are explored. Regulatory issues are addressed. 99 references, 12 figures, 16 tables.

5303 Environmental Impact Statements

5395 **(DOE/EIS—0098) Pantex Plant site, Amarillo, Texas. Final Environmental Impact Statement.** (Department of Energy, Washington, DC (USA)). Oct 1983. 331p. NTIS, PC A15/MF A01. Order Number DE84002955.

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This Environmental Impact Statement evaluates the impact of continuing operations and constructing additional facilities at the Pantex Plant near Amarillo, Texas, in order to meet the Department of Energy's continuing responsibilities for nuclear weapons assembly; stockpile monitoring, maintenance, and modifications; and retirements (disassembly) as mandated by Presidential direction and Congressional authorization and appropriation. The Environmental Impact Statement analyzes a range of alternatives to the proposed action. Alternatives identified include continued operations and construction of new facilities at the Pantex Plant; relocation of some or all of the Pantex Plant operations to existing facilities (which would require refurbishing) or new facilities at a formerly utilized nuclear weapons assembly plant site near Burlington, Iowa; relocation of all operations to new facilities at the Hanford Site near Richland, Washington; and impact mitigation alternatives.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

REFER ALSO TO CITATION(S) 5415

5502 Biochemistry

REFER ALSO TO CITATION(S) 4526

5396 **(DOE/EV/04959—5) Polycyclic aromatic hydrocarbon carcinogen-DNA interactions. Progress report, December 1, 1982-October 31, 1983.** Geacintov, N.E. (New York Univ., NY (USA). Dept. of Chemistry). 7 Nov 1983. Contract AC02-78EV04959. 12p. NTIS, PC A02/MF A01. Order Number DE84003017.

A linear flow dichroism apparatus was designed and built to allow the determination of the kinetics of covalent binding of benzo(a)pyrene-7,8-diol-9,10-epoxide (BPDE) to DNA, and the conformational changes which accompany this binding reaction. The goal is to develop or adopt suitable physico-chemical and spectroscopic techniques to a study of carcinogen-nucleic acid interactions. (ACR)

5397 **(INIS-mf—8427) Composition and biosynthesis of lipids in the healthy human skeletal muscle. Simultaneous in vitro study using ^{3}H-palmitic acid, ^{14}C-acetate and $^{32}PO_4^{3-}$.** Schlenska, K. (Marburg Univ. (Germany, F.R.). Fachbereich Humanmedizin). 30 Nov 1979. 37p. (In German). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703273.

Thesis (Ph.D.).

The skeletal muscle samples were ground in a Warburg Apparatus under oxygen, incubated for 20 to 120 min. at 37 °C together with the three precursors of lipid biosynthesis, and oxygen uptake and $^{14}Co_2$-formation measured. Both parameters showed increasing values during the incubation time. The total lipid extract was isolated from the labelled skeletal muscle samples and was separated, following chromatographic purification on Sephatex-G 25 with the aid of thin-layer chromatography on silica gel, into the following fractions in order of decreasing concentration: phospholipids, triglycerides, cholesterol, mono- and diglyceride fraction, cholesterol ester fraction. Following in-vitro labelling with the three precursors, of the phospholipid fraction [^{3}H] palmilic and showed the highest, increasing incorporation rate, and [^{14}C] acetate the lowest level and slow rate of incorporation. For the central fat fraction labelling incorporation rate decreased in the order: monoglycerides > diglycerides > triglycerides. [^{14}C] acetate labelling occurred to a greater extent in cholestorol esters than in the cholestorol fraction. These findings indicate a de-novo biosynthesis of fatty acids from acetate and their incorporation in mono-, di-and triglycerides and in cholesterol ester. Moreover, incorporation of palmitic and in these fractions, de-novo synthesis of cholesterol, and incorporation of PO_4^{3-} and labelled fatty acids in the phospholipid fraction are also suggested.

5398 **(LA-UR—83-3391) Detection of elements in biomedical fluids by laser-induced breakdown spectroscopy.** Loree, T.R. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 25p. (CONF-831195—3). NTIS, PC A02/MF A01. Order Number DE84003838.

From International congress on applications of lasers and electro-optics; Los Angeles, CA, USA (14 Nov 1983).

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Laser-induced breakdown spectroscopy has been used for the qualitative elemental analysis of human blood, sweat, and serum. The detection of most trace elements, especially metals, was demonstrated.

5503 Cytology

REFER ALSO TO CITATION(S) 5421

5505 Metabolism

REFER ALSO TO CITATION(S) 5425

5506 Medicine

REFER ALSO TO CITATION(S) 5340, 5426, 5532, 5532

5399 **(INIS-mf—8410) Comparative investigations on xeroradiography and convention X-radiation with chronical polyarthritis.** Meisl, T.A. (Muenchen Univ. (Germany, F.R.). Fakultaet fuer Medizin). 2 Oct 1980. 135p. (In German). NTIS (US Sales Only), PC A07/MF A01. Order Number DE83703292.

Thesis (Ph.D.).

We compared the roentgenologic and xeroradiographic findings of the hands of 50 patients suffering from polyarthritis. Both techniques were compared with respect to their imaging quality of roentgenologically significant alterations occurring with chronical polyarthritis. The superiority of xeroradiography bases on the better contour delineation facilities. Disadvantages are the loss of detailed information due to neutralisation effects and also to the impaired representation of areal density differences and of the absolute density of an object. The conventional roentgenologic method is superior with respect to the more informative imaging of areal density modifications, also to the partly better representation of cystic transluences and to a minor degree with respect to a more distinct reproduction of an atrophy of the subchondral lamina terminalis. However, in general it can be said that the results of the two compared techniques do not differ significantly. Consequently the traditional roentgenologic method appears to be the more suitable technique for the diagnosis of chronical polyarthritis.

5400 **(PNL-SA—11656) Preliminary results of testing bioassay analytical performance standards.** Fisher, D.R.; Robinson, A.V.; Hadley, R.T. (Pacific Northwest Lab., Richland, WA (USA)). Aug 1983. Contract AC06-76RL01830. 9p. (CONF-8310143—51). NTIS, PC A02/MF A01. Order Number DE84003350.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

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The analytical performance of both in vivo and in vitro bioassay laboratories is being studied to determine the capability of these laboratories to meet the minimum criteria for accuracy and precision specified in the draft ANSI Standard N13.30, Performance Criteria for Radiobioassay. This paper presents preliminary results of the first round of testing. (ACR)

5401 **Radioimmunoassay of pregnantriol and pregnandiol.** Kuszing, I. Heidelberg, Germany, F.R.; Heidelberg University (1980). 45p. (In German). Library of Heidelberg Univ. (Germany, F.R.).

Thesis (Ph.D.).

A radioimmunoassay for pregnantriol has been developed. The requirement of high sample throughput with small amounts of biological liquid was met by combining the microtiter plate with the 12-sample DC plate and by detection with the beta camera. The results of urinary analyses carried out with this method were compatible with the data of the relevant literature. The method was also found to be suitable for plasma analyses; its suitability as an AGS screening test in prenatal diagnostics will have to be determined by further investigations. Apart from these results, the method could be used for simultaneous determination of pregnandiol.

5402 **Development and application of a radioimmunoassay for Tamm-Horsfall glycoprotein.** Dawnay, A.B.St.J. London, England; London University ([nd]). 188p. British Library, Boston Spa, Wetherby, West Yorks. No. D70076/81.

Thesis (Ph.D.).

Purified urinary Tamm-Horsfall glycoprotein was used to develop specific radioimmunoassays for human serum or plasma samples. One 72 hour assay spanned the range 1.2-39 ng/ml, whilst a rapid 4 hour procedure covered the range 20-1,250 ng/ml. Parallelism was demonstrated between standards and samples; recovery of standard added to serum varied between 96 and 121% and intra- and inter-assay coefficients of variation were less than 10%. The reference range, established in 95 normal subjects, was 70-540 ng/ml and none was detectable in serum from 6 anephric patients. Patients on haemodialysis, but with both kidneys in situ, had low levels and serum levels in healthy kidney donors usually fell following uninephrectomy. In contrast, kidney transplant recipients showed an increase in serum Tamm-Horsfall glycoprotein concentration which stabilised within the normal range only when good graft function was established. Patients in acute renal failure showed a large, but short-lived, rise. These findings support the view that Tamm-Horsfall glycoprotein is a normal constituent of human serum whose levels are related to the functioning mass of the kidney.

5507 Microbiology

REFER ALSO TO CITATION(S) 4519

5403 **(DOE/ER/12079—T1) Microbial ecology summer research program, June 20-August 26, 1983.** (Marine Biological Lab., Woods Hole, MA (USA)). 1983. Contract FG02-82ER12079. 103p. NTIS, PC A06/MF A01. Order Number DE83011525.

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The personnel, lecture topics, and summaries of research reports generated are presented. Research topics include: mutants of Escherichia coli affected in inducer exclusion; anaerobic chitin degradation; feeding relationships of harpacticoid copepods and microbial flora; degradation of ortho phenyl phenol by streptomycetes; biodegradation of dieldrin and aromatic compounds; the effect of neurotoxins on chemotaxis is Spirochaeta aurantia; chemotaxis and algal attachment of caulobacter; pigment formation in Lyngbya aestuari; diel movements of bacteria in a salt marsh; chemotaxis in S. Aurantia; isolation of marine toluate-oxidizing bacteria; growth inhibition of enteric bacteria by methyl-α-D-glucoside; studies of magnetic bacteria in brackish waters; and mechanisms of interaction between two microbial populations in activated sludge. (ACR)

5510 Physiological Systems

REFER ALSO TO CITATION(S) 5420

5530 Agriculture And Food Technology

REFER ALSO TO CITATION(S) 5374

5404 **(DOE/R4/10153—T2) Energy recovery through termites. Final report.** Granger, J.A. (Granger (James A.), Tallahassee, FL (USA)). 15 Dec 1981. Contract FG44-80R410153. 24p. NTIS, PC A02/MF A01. Order Number DE84000750.

This project, Energy Recovery Through Termites, was based on the proposed development of an energy recovery system to produce low cost animal protein for use in animal feeds. The result of my study shows that to date we are unable to establish viable colonies of termites. This is based on several key factors as follows: (a) inability to capture reproductives to establish new colonies in a confined area needed to offer recovery or harvest of protein; (b) confinement of colonies (even without queen or reproductives) has proven to be far too complex to establish in low cost and modest facilities; (c) the proposal is not cost effective. The resources of skill and materials could not be repaid from the protein recovered.

5405 **(TVA/ONR/LFR—83/09) Container production and nursery evaluation of native herbaceous plants for landscaping and revegetation of disturbed sites.** Cunningham, M.; Farmer, R.E. Jr. (Tennessee Valley Authority, Norris (USA). Div. of Land and Forest Resources). Jan 1983. 21p. NTIS, PC A02/MF A01. Order Number DE84900352.

Thirty-two species in the genera Asclepias, Aster, Bidens, Coreopsis, Chrysopsis, Eupatorium, Echinacea, Helenium, Helianthus, Lobelia, Rudbeckia, Solidago, and Vernonia were propagated by seed from wild populations in eastern Tennessee. Seed were collected at dispersal in the fall, preliminary dormancy and germination tests conducted, and seed treated in accordance with test results to obtain greenhouse germinants. Seed were sown in late February on MetroMix in Rootrainers and transplanted to an irrigated nursery in early May. Survival was over 90%, and all but one species flowered and seeded abundantly during the first season. Observations of growth habit, flowering, and seed dispersal were recorded.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

REFER ALSO TO CITATION(S) 4739

5406 **(BNL—33752) Effects of high vs low-level radiation exposure.** Bond, V.P. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 67p. (CONF-8304123—2). NTIS, PC A04/MF A01. Order Number DE84002880.

From Symposium on the health aspects of nuclear power plant incidents; New York, NY, USA (7 Apr 1983).

In order to appreciate adequately the various possible effects of radiation, particularly from high-level vs low-level radiation exposure (HLRE, vs LLRE), it is necessary to understand the substantial differences between (a) exposure as used in exposure-incidence curves, which are always initially linear and without threshold, and (b) dose as used in dose-response curves, which always have a threshold, above which the function is curvilinear with increasing slope. The differences are discussed first in terms of generally familiar nonradiation situations involving dose vs exposure, and then specifically in terms of exposure to radiation, vs a dose of radiation. Examples are given of relevant biomedical findings illustrating that, while dose can be used with HLRE, it is inappropriate and misleading the LLRE where exposure is the conceptually correct measure of the amount of radiation involved.

5407 **(INIS-mf—8405) Influence of X-rays on the ploidy of murine liver cells.** Hering, F.; Willers, R. (Dortmund Univ. (Germany, F.R.). Abt. Statistik). Jul 1980. 48p. (In German). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703269.

The study has been made in order to investigate to which extent X-rays may cause more rapid degeneration and thus an early development of cells with high ploidy. For the experiments, mice from four different strains with various life expectancy have been chosen; the animals have been irradiated with 50 or 400 R and killed at ages ranging from 30-540 days. It is shown that there is a positive relation between age and ploidy of cells.

5408 **(INIS-mf—8406) Effects of ionizing radiation and the molecular and cellular mechanisms.** (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Biologie; Deutsche Roentgengesellschaft, Gesellschaft fuer Medizinische Radiologie, Strahlenbiologie und Nuklearmedizin e.V., Hamburg (Germany, F.R.). Arbeitsgemeinschaft fuer Strahlenbiologie; Deutsche Gesellschaft fuer Biophysik e.V., Frankfurt am Main (Germany, F.R.)). 1982. 65p. (In German, English). (CONF-8203134—). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703268.

From Symposium on effects of ionizing radiation and the molecular and cellular mechanisms; Munich, F.R. Germany (17 Mar 1982).

This symposium with its 60 contributions presents a survey of the current state of the art in molecular radiation biophysics and radiobiology in the FRG. Many contributions show the trend of applying findings in these fields to cancer research. The various sessions have been devoted to: 1) Radiation chemistry of biomolecules; 2) DNA damage and repair; 3) Repair of DNA damage; 4) Cell proliferation and cell inactivation; 5) Cancerogenesis, mutation and chromosomal damage; 6) Effects of heavy ions.

5409 **(INIS-mf—8456) Autologous stem cell transplantation following high-dose whole-body irradiation of dogs - influence of cell number and fractionation regimes.** Bodenberger, U. (Muenchen Univ. (Germany, F.R.). Fachbereich Tiermedizin). 24 Jul 1981. 73p. (In German). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703270.

Thesis (Ph.D.).

The acute radiation syndrome after a single dose of 1600 R (approx. 12-14 Gy in body midline) and after fractionated irradiation with 2400 R (approx. 18-20 Gy) was studied with regard to fractionation time and to the number of bone marrow cells infused. The acute radiation syndrome consisted of damage to the alimentary tract and of damage to the hemopoietic system. Damage of hemopoiesis was reversible in dogs which had been given a sufficient amount of hemopoietic cells. Furthermore changes in skin and in the mucous membranes occurred. Hemopoietic recovery following infusion of various amounts of bone marrow was investigated in dogs which were irradiated with 2400 R within 7 days. Repopulation of bone marrow as well as rise of leukocyte and platelet counts in the peripheral blood was taken as evidence of complete hemopoietic reconstitution. The results indicate that the acute radiation syndrom following 2400 R TBI and autologous BMT can be controlled by fractionation of this dose within 5 or 7 days. The acute gastrointestinal syndrome is aggravated by infusion of a lesser amount of hemopoietic cells. However, TBI with 2400 R does not require greater numbers of hemopoietic cells for restoration of hemopoiesis. Thus, the hemopoiesis supporting tissue can not be damaged by this radiation dose to an essential degree. Longterm observations have not revealed serious late defects which could represent a contraindication to the treatment of malignent diseases with 2400 R of TBI.

5410 **(INIS-mf—8459) Basic standards for radiation protection.** Webb, G.A.M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1982. 15p. (CONF-8209134—2). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703289.

From IAEA interregional training course on waste management in nuclear facilities; Karlsruhe, F.R. Germany (6 Sep 1982).

The basic standards for radiation protection have been based, for many years, on the recommendations of the International Commission of Radiological Protection. The three basic standards recommended by the Commission may be summarized as "justification, optimization of protection and adherence to dose limitations. The applications of these basic principles to different aspects of protection are briefly summarized and the particular ways in which they have been applied to waste described in more detail. The application of dose limits, both in the control of occupational exposure and in regulating routine discharges of radioactive effluents is straight forward in principle although the measurement and calculational requirements may be substantial. Secondary standards such as derived limits may be extremely useful and the principles underlying their derivation will be described. Optimization of protection is inherently a more difficult concept to apply in protection and the various techniques used will be outlined by with particular emphasis on the use of cost benefit analysis are recommended by the ICRP. A review will be given of the problems involved in extending these basic concepts of the ICRP to probabilistic analyses such as those required for assessing the consequences of accidents or disruptive events in long term repositories. The particular difficulties posed by the very long timescales involved in the assessment of waste management practices will be discussed in some detail.

5411 **(INIS-mf—8468) Decontamination of persons and other medical measures.** Ohlenschlaeger, L. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Schule fuer Kerntechnik). 1982. 9p. (CONF-8209134—1). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703272.

From IAEA interregional training course on waste management in nuclear facilities; Karlsruhe, F.R. Germany (6 Sep 1982).

Medical measures in case of radiation damages are discussed on the basis of five potential categories of radiation incidents or accidents, namely contaminations, incorporations, external local and general radiation over-exposures, contaminated wounds, and combinations of radiation damages and conventional injuries. Considerations are made for diagnostic and therapeutic initial measures especially in case of minor and moderate radiation accidents. The medical emergency planning is reviewed by means of definitions used in the practical handling of radiation incidents or accidents. The parameters are: extent of the incident or accident, number of persons involved, severity of the radiation damage. Based on guiding symptoms the criteria for the classification into minor, moderate or severe radiation accidents are discussed.

5412 **1976 Hanford americium exposure incident: overview and perspective.** Thompson, R.C. (Pacific Northwest Lab., Richland, WA). *Health Physics;* **45**: No. 4, 837-845(Oct 1983). Contract AC06-76RL01830.

Salient features of the 1976 Hanford americium exposure incident are discussed. Comparisons are made with previous human and animal exposure data, and conclusions drawn relative to the injured workman, to health physics practices, and to the adequacy of current exposure limits.

5413 **1976 Hanford americium exposure incident: accident description.** McMurray, B.J. (Pacific Northwest Lab., Richland, WA). *Health Physics;* **45**: No. 4, 847-853(Oct 1983). Contract AC06-76RL01830.

An accident is described which involved the explosion of an ion-exchange column containing about 100 g of ^{241}Am. A chemical operator was injured in this accident, receiving acid burns and superficial cuts on the upper part of his body. From 1 to 5 Ci of ^{241}Am is estimated to have been deposited on the injured worker and on his clothing.

5414 **1976 Hanford americium exposure incident: medical management and chelation therapy.** Breitenstein, B.D. (Hanford Environmental Health Foundation, Richland, WA). *Health Physics;* **45**: No. 4, 855-866(Oct 1983). Contract AC06-76RL01837.

A chronological account is given of the general medical management of a patient involved in an americium exposure incident. The use of DTPA was begun.

5415 **1976 Hanford americium exposure incident: phychological aspects.** Brown, W.R. (Hanford Environmental Health Foundation, Richland, WA). *Health Physics;* **45**: No. 4, 867-871(Oct 1983). Contract AC06-76RL01837.

Accidents involving exposure to radiation or radioactive materials may involve an unusual degree of emotional trauma. Methods that may be employed in dealing with such trauma are discussed in relation to a specific accident in which a radiation worker was injured and seriously contaminated with ^{241}Am.

5416 **1976 Hanford americium exposure incident: external decontamination procedures.** Jech, J.J. (Pacific Northwest Lab., Richland, WA); Berry, J.R.; Breitenstein, B.D. *Health Physics;* **45**: No. 4, 873-881(Oct 1983). Contract AC06-76RL01830;AC06-76RL01837.

An accident resulted in the deposition on an injured workman's skin surfaces, in acid-burned areas and in lacerations, of something in excess of 6 mCi ^{241}Am. This paper describes the external decontamination procedures used, the change in americium content of the skin during the course of treatment, and some of the unusual problems encountered from the extrusion of foreign material and flaking of skin and scar tissue.

5417 **1976 Hanford americium exposure incident: decontamination and treatment facility.** Berry, J.R. (Pacific Northwest Lab., Richland, WA); McMurray, B.J.; Jech, J.J.; Breitenstein, B.D.; Quigley, E.J. *Health Physics;* **45**: No. 4, 883-892(Oct 1983). Contract AC06-76RL01830;AC06-76RL01837.

An injured worker, contaminated with more than 6 mCi of ^{241}Am required special treatment and housing for 4 months. This paper is a description of the design and management of the facility in which most of the treatment and housing occurred. The problems associated with contamination control, waste handling, supplies and radiological concerns during the two-stage transfer of the patient from a controlled situation to his normal living environment are discussed in detail.

5418 **1976 Hanford americium exposure incident: in vivo measurements.** Palmer, H.E. (Pacific Northwest Lab., Richland, WA); Rieksts, G.A.; Icayan, E.E. *Health Physics;* **45**: No. 4, 893-910(Oct 1983). Contract AC06-76RL01830;AC06-76RL01837.

Detailed external measurements were made of internally deposited ^{241}Am in a nuclear chemical operator involved in an americium exposure accident at the Hanford plant. Despite some interference from high-level external contamination, quantitative measurements of the ^{241}Am content in the lung, liver and bones were made starting on the third day after the accident. The rate of excretion of ^{241}Am from these organs was determined. The ^{241}Am embedded in the skin of the face and head was carefully mapped. The distribution over the total length of the body was also determined. Linear and rectilinear scanners, γ cameras, large and small scintillation detectors, proportional counters, and Si(Li) and intrinsic germanium detectors were used to evaluate the internal deposition. Methods of calibration for quantitative measurement included simulation of the ^{241}Am activity in both phantom and cadaver parts.

5419 **1976 Hanford americium exposure incident: organ burden and radiation dose estimates.** Robinson, B.; Heid, K.R.; Aldridge, T.L.; Glenn, R.D. (Pacific Northwest Lab., Richland, WA). *Health Physics;* **45**: No. 4, 911-921(Oct 1983). Contract AC06-76RL01830.

A Hanford worker received an intake of ^{241}Am by skin absorption and inhalation which was later evaluated to be in excess of 1 mCi. The skin was the main pathway for introduction of ^{241}Am into the body; however inhalation was also a significant pathway. Intensive DTPA therapy prevented 99% of ^{241}Am which entered the blood stream from being deposited in the internal organs. Retention and distribution of ^{241}Am in various internal organs and tissues was determined from sequential measurements in vivo using several arrangements of externally located scintillation detectors. The organ and tissue retention and distribution have been followed for longer than 5 yr. Excretion patterns and estimates of radiation dose to the lung, liver, bone and skin are described.

5420 **1976 Hanford americium exposure incident: hematologic effects.** Ragan, H.A. (Pacific Northwest Lab., Richland, WA); Mahaffey, J.A.; Breitenstein, B.D. *Health Physics;* **45**: No. 4, 923-932(Oct 1983). Contract AC06-76RL01830;AC06-76RL01837.

Hematologic evaluation of an individual with an initial systemic body burden of $\sim$ 200 μCi ^{241}Am revealed a significant ($P < 0.01$) reduction of total leukocytes, neutrophils and lymphocytes. This effect on total leukocytes and neutrophils was evident $\sim$ 30 days after exposure, appeared to stabilize at about 3 months after exposure, and remained at this lower level through a 52-month observation period. The effect on lymphocytes was apparent by 3 days after exposure, stabilizing at $\sim$ 50% of pre-exposure values for about 7 months, with a return to pre-exposure levels in the following 4 yr. There was a progressive and significant ($P < 0.001$) decline in platelet counts during the 52-month post-exposure period. The pattern of response in erythrocyte parameters was complex. Immediately after the accident, these values were less than the pre-exposure mean level, they gradually increased ($P < 0.001$) for $\sim$ 2 yr and then began a progressive decline ($P < 0.001$).

5421 **1976 Hanford americium exposure incident: histologic and autoradiographic observations on skin.** Hampton, J.C. (Pacific Northwest Lab., Richland, WA). *Health Physics;* **45**: No. 4, 933-935(Oct 1983). Contract AC06-76RL01830.

Examination of biopsies from exposed and relatively unexposed areas of the face revealed changes that were consistent with actinic elastic degeneration associated with solar exposure, except in areas in which sources of α radiation were detected in the upper dermis. In those areas, particles judged to be ion-exchange resin were found within a few macrophages and extracellularly among connective tissue fibers. Elastic fibers in those areas showed more advanced degenerative change than fibers not closely associated with heavy concentrations of α radiation.

5422 **Deposition and retention of 0.1 micron $^{67}Ga_2O_3$ aggregate aerosols in rats following whole body exposures.** Wolff, R.K.; Griffis, L.C.; Hobbs, C.H.; McClellan, R.O. (Lovelace Biomedical and Environmental Research Institute, Albuquerque, New Mexico). *Fundamental and Applied Toxicology;* **2**: No. 4, 195-200(Jul-Aug 1982).

Determinations were made of respiratory tract deposition and gastrointestinal tract burdens following whole body inhalation exposures, typical of those used in many chronic exposures; these were compared to values obtained in nose-only exposures. Fischer-344 rats were exposed in large volume chambers, in a whole body mode, to 0.1 micron volume median diameter (VMD) $^{67}Ga_2O_3$ particles 5 hrs/day. Deposition per unit of exposure time and retention were essentially identical following either 1 or 3 day exposures. The lung deposition of particles was 2.8 units/hr for males and 2.2 units/hr for females if the exposure concentration was expressed as 1 unit/L. These values represent a deposition of approximately 15% of the inhaled particles, similar to values obtained for nose-only exposures. Aerosol deposition per kgm body weight was 24% higher in females than males. Passage of material into the gastrointestinal tract was 1.6-fold greater for these whole body exposures as compared to nose-only exposures to the same aerosol mainly resulting from extra material ingested by grooming of the pelt. Approximately 60% of the pelt burden was calculated to be ingested following whole body exposures.

5423 **Experimental study of possible therapy of the acute radiation syndrome. Influence of corticoids and of an antibiotic.** Willborn, M. Bonn, Germany; Bonn University (1981). 27p. (In German). Library of Bonn Univ. (Germany, F.R.).

Thesis (Ph.D.).

These experimental studies showed that the survival time of rats, irradiated in a whole-body irradiation with 3000 rad ^{60}Co-gamma, can be positively influenced by the administration of an antibiotic and also by glucocorticoids. Contrary to our expectations, the combined application of the glucocorticoid and the antibiotic did not increase the survival time of the animals with gastrointestinal syndromes compared with the exclusive administration of the antibiotic. The mineral corticoid aldosterone resulted to be ineffective.

5424 **Effects of x-irradiation in the mosquito Aedes aegypti (L).** Read, N.G. London, England; London University (1980). 306p. British Library, Boston Spa, Wetherby, West Yorks. No. D70246/81.

Thesis (Ph.D.).

Newly emerged mosquitoes (Aedes aegypti (L)) were exposed to doses of 500 to 32,000 rad X-irradiation and the LD_{50} and mean survival time determined. Radiation doses between 500 and 8,000 rad had only a slight effect on longevity whereas exposure to 32,000 had an appreciable effect. The midgut structure of newly emerged, X-irradiated female Aedes aegypti imagines was examined at set intervals after irradiation. The cytochemical localization of midgut acid phosphatase, alkaline phosphatase and adenosine triphosphatase, and also quantitative estimates of midgut acid and alkaline phosphatase were carried out on mosquitoes exposed to 32,000 rad. Considerable changes in the structure of the midgut cells were apparent. With 500, 4,000 and 8,000 rad there was evidence of cellular repair and recovery. However, with 32,000 rad cellular damage was most extensive, with considerable loss of cell structure. The ultrastructural changes noted suggest that the primary radiation damage was to the plasma and organelle membranes, which is in agreement with the membrane-damage/enzyme release hypothesis.

5603 Chemicals Metabolism And Toxicity

REFER ALSO TO CITATION(S) 4296, 4299, 4299, 4301, 4308, 4310, 5079, 5396, 5423

5425 **(CONF-8310197—2) Metabolism and toxicity of cadmium and lead during pregnancy and lactation.** Bhattacharyya, M.H. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE84003673.

From DOE reproductive toxicology workshop; San Francisco, CA, USA (12 Oct 1983).

Four projects relating to the metabolism and toxicity of cadmium and lead during pregnancy and lactation are summarized. Increased GI absorption and accumulation of cadmium is increased in the tissues of the mother during pregnancy and lactation in the mouse, but very little cadmium is transferred to pups. Greater than 90% of the cadmium that is transferred to pups during lactation comes from the diet not from previous body stores. Female mice exposed to a deficient Itai-Itai household diet and 50 ppM Cd show cadmium-induced decreases in reproductive parameters. Multiparous mice exposed to 50 ppM Cd develop changes in bone mineral content possibly related to similar changes seen in Itai-Itai disease. Lead absorption by the mouse dam increases only slightly during lactation, but lead is readily transferred to pups.

5426 **(INIS-mf—8457) Excretion and organic distribution of ^{57}Co-bleomycin emulsions.** Lathan, B. (Freie Univ. Berlin (Germany, F.R.). Fachbereich Humanmedizin). 11 Jan 1982. 73p. (In German). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703293.

Thesis (Ph.D.).

Excretion and organic distributions of ^{57}Co-bleomycin were studied in normal and tumour-bearing mice with the objective of obtaining high ^{57}Co-bleomycin concentrations in the tumour and the regional lymph nodes. Aqueous ^{57}Co-bleomycin and various ^{57}Co-bleomycin emulsions were used for the studies and applied either locally or systemically. Excretion of ^{57}Co-bleomycin was slowest after local administration of ^{57}Co-bleomycin oil-in-water emulsion and fastest after systemic application of aqueous ^{57}Co-bleomycin. Organic distribution studies showed the highest values in the tumour and the regional lymph nodes after local injection of ^{57}Co-bleomycin oil-in-water emulsion while the lowest values were measured after systemic application of aqueous ^{57}Co-bleomycin. These kinetic studies suggest that intratumoral treatment with oil-in-water emulsions of bleomycin may be a new approach in the therapy of epithelial tumours with lymphogenic metastases.

5427 **(LBL—16686) Yeast screening system for the detection of mutation, recombination, and aneuploidy.** Dixon, M.L. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 214p. NTIS, PC A10/MF A01. Order Number DE84002180.

Thesis.

Two strains of the yeast Saccharomyces cerevisiae were constructed to detect genetic damage. Strain XD99 can detect chromosome loss, important in the induction of teratogenesis, aneuploidy, and possibly carcinogenesis. Two positive selection techniques were developed which select for the simultaneous loss of both arms of chromosome X. Confirmation of chromosome loss using a centromere-linked marker was found to be essential for distinguishing chromosome loss from coincident crossing-over. The high selectivity of strain XD99 allowed the development of a spot test for chromosome loss. Methyl benzimidazole-2-yl-carbamate and ethyl methanesulfonate induced chromosome loss in the spot test. The two carcinogens 4-nitroquinoline-N-oxide and N-methyl-N'-nitro-N-nitrosoguanidine also induced chromosome loss. Chromosome X monosomics were found to be unstable and were restored to euploidy. This restoration of euploidy may have important implications regarding chromosome loss as a mechanism of promotion.

Strain XD83 can detect multiple genetic changes: nuclear frameshift and base pair substitution mutations, nuclear mitotic crossing-over and gene conversion and mitochondrial large deletions and forward point mutations. Ethyl methanesulfonate, ICR-170, N-methyl-N'-nitro-N-nitrosoguanidine, 4-nitroquinoline-N-oxide, ultraviolet light and ethidium bromide were tested. None of the carcinogens were specific in their induced spectrum of damage. Only ethidium bromide induced a highly specific spectrum of damage: petite induction. The variety of endpoints monitored here may allow the detection of certain carcinogens and other genetically toxic agents which have escaped detection in other systems. This system may be useful in the study of possible mechanisms of carcinogenesis and aneuploidy.

5428 **(ORNL/PPA—83/8) Estimating exposures and health effects of organic pollutants: research needs and uncertainties.** Holton, G.A.; Calle, E.E.; Talmage, S.S. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 27p. NTIS, PC A03/MF A01. Order Number DE84002987.

Using environmental exposure to benzo(a)pyrene in the United States as an example, many sources of uncertainty are illustrated. Research needs identified include determining how combustion conditions affect organic emission composition; improving measurement accuracy and precision at nanograms per cubic meter levels; determining chemical half-lives in atmospheric, water and soil conditions; and determining bioaccumulation and biomagnification of organics through the food chain. More study is also required to relating populations to exposure to human health endpoints in the same populations. Lack of adequate human data to assess risk of a substance requires implementation of methodologies which use subhuman data. Development of human dose response relationships from such methodologies requires improved chemical characterization and concentration of complex mixtures to which various human population groups are exposed.

5429 **Mutagenicity of diesel exhaust particle extracts: influence of fuel composition in two diesel engines.** Clark, C.R.; Henderson, T.R.; Royer, R.E.; Brooks, A.L.; McClellan, R.O.; Marshall, W.F.; Naman, T.M. (Inhalation Toxicology Research Institute, Lovelace Biomedical and Environmental Research Institute, Albuquerque, NM). *Fundamental and Applied Toxicology;* **2**: No. 1, 38-43(Jan-Feb 1982).

The influence of diesel fuel composition on mutagenicity of exhaust particle associated organic compounds has been investigated using nine fuels varying in aromatic content and distillation properties. The tests were conducted with Oldsmobile Delta-88 and Peugot 504 diesel cars operated according to the EPA Federal Test Procedure. The particulate exhaust from each test was collected on a filter, extracted in dichloromethane and the resulting extract evaluated for mutagenicity in Salmonella strain TA-100. Mutagenicity of extracts of particles collected from the Oldsmobile were highest in the higher aromatic content fuels (greater than 30%) but similar for intermediate (20%) and low (13%) aromatic content fuels. No influence of aromaticity on mutagenicity was observed in samples collected from the Peugeot under the same conditions. Thus, fuel aromatic content may enhance the production of mutagenic combustion products at higher concentrations, but may be dependent upon engine type. A good correlation was observed between mutagenicity of the particle extracts and the initial boiling point of the fuel (r ? 0.89). Gas chromatography/mass spectrometric analysis of the aromatic fraction of the fuels showed that the fuel producing the most mutagenic combustion products was highest in phenanthrene type compounds.

5604 Other Environmental Pollutant Effects

5430 (CONF-8207101—, pp 16-24) **US Department of Energy 60-Hz electric fields bioeffects research.** Bulawka, A.O. (US Dept. of Energy, Washington, DC); Wisecup, W.G.; Rosen, L.A.; Feero, W.E.; Dietrich, F.M. 1982. NTIS, PC A17/MF A01.

From Italy/US joint ultra high voltage transmission technology workshop; Portland, OR, USA (25 Jul 1982).

Major difficulties exist in reliably evaluating the consequences of human and animal exposure to electric fields from transmission lines: lack of experimental and epidemiological data on human exposures, insufficient data from experimental animals, lack of an understanding of the basic mechanisms by which low-intensity fields interact with biological systems, and problems in extrapolating data from animals to humans. Research to date has not resolved these difficulties, but it has led to significant advances in methodologies and an accumulation of effects data. This paper summarizes the results of the last 5 years of DOE research in this area.

58 GEOSCIENCES

5801 Geology And Hydrology

REFER ALSO TO CITATION(S) 5376

5431 **(CONF-8310199—2) Role of geomorphic thresholds in determining alluvial channel morphology.** Edgar, D.E. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 12p. NTIS, PC A02/MF A01. Order Number DE84003627.

From Rivers '83 symposium; New Orleans, LA, USA (24 Oct 1983).

Results of a combined laboratory and field investigation indicate that threshold conditions are associated with major changes in alluvial channel morphology. Thirty-one different channels were generated in the laboratory under a range of slope, discharge, and bedload transport conditions. At low values of these variables, straight channels were formed. As the values of these variables were progressively increased, threshold conditions were exceeded and meandering-thalweg channels resulted. The degree of meandering, as measured by thalweg sinuosity, increased with commensurate increases in the independent variables until critical conditions were again encountered. At this point, meandering tendencies abruptly decreased, and only braided channels were produced. When the sinuosity of these channels was plotted against slope, stream power, and other key variables, the presence and effect of thresholds became apparent. To test these observations under field conditions, geomorphic and hydrologic data were collected on 45 streams of widely ranging sizes in Indiana and Illinois. Variations analogous to those in the laboratory were observed, although there was comparatively more variation in the field relationships. From these and related results from other studies, it is clear that thresholds exist within the range of certain controlling variables and that when these thresholds are exceeded through natural processes or human influence, dramatic changes in channel morphology can occur. 38 references, 4 figures.

5432 **(INIS-BR—15) Utilization of Weibull equation to obtain soil-water diffusivity in horizontal infiltration.** Guerrini, I.A. (Sao Paulo Univ., Piracicaba (Brazil). Escola Superior de Agricultura Luiz de Queiroz). Jun 1982. 105p. (In Portuguese). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83703267.

Thesis (Ph.D.).

Water movement was studied in horizontal infiltration experiments using laboratory columns of air-dry and homogeneous soil to obtain a simple and suitable equation for soil-water diffusivity. Many water content profiles for each one of the ten soil columns utilized were obtained through gamma-ray attenuation technique using a ^{137}Cs source. During the measurement of a particular water content profile, the soil column was held in the same position in order to measure changes in time and so to reduce the errors in water content determination. The Weibull equation utilized was excellent in fitting water content profiles experimental data. The use of an analytical function for A, the Boltzmann variable, according to Weibull model, allowed to obtain a simple equation for soil water diffusivity. Comparisons among the equation here obtained for diffusivity and others solutions found in literature were made, and the unsuitability of a simple exponential variation of diffusivity with water content for the full range of the latter was shown. The necessity of admitting the time dependency for diffusivity was confirmed and also the possibility fixing that dependency on a well

known value extended to generalized soil water infiltration studies was found. Finally, it was shown that the soil water diffusivity function given by the equation here proposed can be obtained just by the analysis of the wetting front advance as a function of time.

5433 (ORNL—5976) FEWA: a Finite Element model of Water flow through Aquifers. Yeh, G.T.; Huff, D.D. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 222p. NTIS, PC E09/MF A01. Order Number DE84002980.

Includes 6 sheets of 24x reduction microfiche; Environmental Science Division Publication No. 2240.

This report documents the implementation and demonstration of a Finite Element model of Water flow through Aquifers (FEWA). The particular features of FEWA are its versatility and flexibility to deal with as many real-world problems as possible. Point as well as distributed sources/sinks are included to represent recharges/pumpings and rainfall infiltrations. All sources/sinks can be transient or steady state. Prescribed hydraulic head on the Dirichlet boundaries and fluxes on Neumann or Cauchy boundaries can be time-dependent or constant. Source/sink strength over each element and node, hydraulic head at each Dirichlet boundary node, and flux at each boundary segment can vary independently of each other. Either completely confined or completely unconfined aquifers, or partially confined and partially unconfined aquifers can be dealt with effectively. Discretization of a compound region with very irregular curved boundaries is made easy by including both quadrilateral and triangular elements in the formulation. Large-field problems can be solved efficiently by including a pointwise iterative solution strategy as an optional alternative to the direct elimination solution method for the matrix equation approximating the partial differential equation of groundwater flow. FEWA also includes transient flow through confining leaky aquifers lying above and/or below the aquifer of interest. The model is verified against three simple cases to which analytical solutions are available. It is then demonstrated by two examples of how the model can be applied to heterogeneous and anisotropic aquifers with transient boundary conditions, time-dependent sources/sinks, and confining aquitards for a confined aquifer of variable thickness and for a free surface problem in an unconfined aquifer, respectively. 20 references, 25 figures, 8 tables.

5434 In-situ determining the unsaturated hydraulic conductivity ksub(u) in ground- and backwater soils by the evaporation method with the neutron-gamma probe and with tensiometers. Krahmer, U. bonn, Germany F.R.; Bonn University (1973). 137p. (In German). Library of Bonn Univ. (Germany F.R.).

Thesis (Ph.D.).

The unsaturated hydraulic conductivity ksub(u) is determined in this work as soil parameter under free land, weather and vegetation conditions using the evaporation method. In the applied method with in-situ measurements one assumes that water rises in the root fringes as a capillary from the ground or moisture-retaining soil layers or from the water unsaturated soil zone by means of evapotranspiration effects; i.e. the water is evaporated at the surface or consumed by the plants. The hence resulting moisture and unavoidable changes in potential over a certain period of time are the basis for the measuring principle. Moisture-retaining soils from the saale ice-age ground moraine deposits of the western Muensterland were mainly used as samples from which a few essential soil-physical and chemical analyses could be performed. The tensiometer and the neutron gamma depth probe were provided by the firm Berthold to measure and determine the unsaturated hydraulic conductivity Ksub(u) in the suction tension region of 0 to 900 cm WS.

5802 Geophysics

REFER ALSO TO CITATION(S) 4360, 4361, 4362, 4363, 5140

5435 (DOE/ER/03134—46) Comprehensive study of the seismotectonics of the eastern Aleutian arc and associated volcanic systems. Annual progress report, March 1, 1983-February 29, 1984. Jacob, K.H.; Hauksson, E.; McNutt, S.; Davison, R.; Beavan, J.; Rosen, S.; Luckman, M.A.; Johnson, D.; Skinta, L. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). 1 Nov 1983. Contract AC02-76ER03134. 65p. (COO—3134-46). NTIS MF A01. Order Number DE84002243.

Microfiche only, copy does not permit paper copy reproduction.

Integration of seismic network data from the Shumagin Islands seismic gap with crustal deformation and volcanicity data indicate that the previously reported tilt anomaly in 1978 to 1980 was associated with an 80-cm amount of slip of the descending slab at depth between 20 and $\approx$ 80 km. The slip event was mostly aseismic although it caused increasing microearthquake activity. The shallow ($<$ 30 km) main thrust zone remained locked but may have been further stressed so as to increase the likelihood for a future great earthquake. The basic conditional probability for the Shumagin Gap rupture in a great earthquake ($M > \approx 8$) in the next decades has been determined to lie between 30 and 99%, probably the highest value for a potential great earthquake anywhere in the US. Composite focal mechanisms close to the location of the slip event are found to be highly variable since 1978 (both in space and time). An earthquake sequence in the Shumagins of February 14, 1983, included two moderately large shocks, $M = 6.3$ and 5.7, that provided significant strong-motion records. Three dimensional ray tracing has been applied to relocate hypocenters in the descending slab and thereby redefining the dipping slab geometry. We find the slab dips beneath 80 km at an almost constant dip of $\approx 45°$ to depths of $\approx$ 250 km without significant bend. 12 references.

5436 (LA—9900-PR) Earthquake catalog for northern New Mexico. Progress report, April-June 1983. Cash, D.J.; Olsen, K.H.; Stewart, J.N.; Wolff, J.J. (Los Alamos National Lab., NM (USA)). Sep 1983. Contract W-7405-ENG-36. 11p. NTIS, PC A02/MF A01. Order Number DE84003554.

This report is a summary of the earthquakes located in northern New Mexico by the Los Alamos National Laboratory seismic array. Data are presented in the form of tables and epicenter maps, with a brief explanatory text. 6 references.

5437 (N—8326153) Implications of information from LANDSAT-4 for private industry. Everett, J.R.; Dykstra, J.D. (Earth Satellite Corp., Chevy Chase, MD (USA)). 1983. 7p. (E—83-10330; NASA-CR—170385). NTIS, PC A02/MF A01.

The broader spectral coverage and higher resolution of LANDSAT-4 Thematic Mapper (TM) data open the door for identification from space of spectral phenomena associated with mineralization and microseepage of hydrocarbon. Digitally enhanced image products generated from TM data allow the mapping of many major and minor structural features that mark or influence emplacement of mineralization and accumulation of hydrocarbons. These improvements in capabilities over multispectral scanner data should accelerate the acceptance and integration of satellite data as a routinely used exploration tool that allows rapid examination of large areas in considerable detail. Imagery of Southern Ontario, Canada as well as of Cement, Oklahoma and Death Valley, California is discussed.

5438 (USGS-OFR—83-616) Aeromagnetic map of Yucca Mountain and surrounding regions, southwest Nevada. Kane, M.F.; Bracken, R.E. (Geological Survey, Denver, CO (USA)). 1983. Contract AI08-78ET44802. 78p. NTIS, PC A05/MF A01. Order Number DE84003920.

Magnetic anomalies over Yucca Mountain and surround areas are largely caused by variations in magnetic properties and shapes, including structural offsets, of the extensive volcanic units that underlie the region. In a few places the anomalies are caused

by intrusions. Correlation between magnetic properties measured from rock samples and those derived from rock unit-magnetic anomaly associations is excellent. Anomaly characteristics, extensive magnetic gradients, and marked changes in the regional magnetic field can be coupled with the magnetic properties of the rock units to delineate structural boundaries. Three major boundaries are indicated by contrasts in regional magnetic expressions. Less extensive but more clearly indicated boundaries in the immediate vicinity of Yucca Mountain are interpreted from a distinctive pairing of northerly-displacement in generally gently dipping volcanic beds. The displacement between beds is located approximately along the border line between the linear anomaly pairs. One series of pairs of more northeasterly trend lies over the general location of a change from moderately thick to very thick volcanic units that was interpreted from gravity data. Several low amplitude but distinctively shaped anomalies in areas underlain primarily by sedimentary strata indicate the presence of intrusions and faults. 14 references, 2 figures.

5439 **Site-structure dependent excitations.** Philippacopoulos, A.J. (Brookhaven National Lab., Upton, NY (USA)). *Nuclear Engineering and Design;* **74**: No. 2, 153-163(Feb 1983).

A method for generation of site-structure dependent seismic excitations is presented. These are constructed from past recorded earthquake accelerograms and have the property to produce upper bounds in the response of a given structure. Their application in the seismic assessment of structures indicates that they produce highly reliable results under an acceptable design conservatism. The approach presented, complements currently used procedures for assessments of earthquake structural resistance when higher levels of confidence are required. Currently used procedures are based on inputs derived by statistical analyses of past recorded earthquake accelerograms under the assumption of different probability distributions. The one described here utilizes such records and in addition takes into account the response characteristics of a given structure. It is based on a well founded mathematical formulation and is suitable for adapation on computers used today in the engineering community. Typical seismic evaluations based on rigorous application of the method are demonstrated. Simplifications for practical engineering applications are also described. The conclusion is that these site-structure dependent seismic excitations should not be excluded in seismic assessments of nuclear structures which require high levels of confidence.

5805 Oceanography

5440 **(N—8327253) Phase variation in wave force data.** Pearcey, H.H. (National Maritime Inst., Feltham (UK)). Feb 1982. 15p. Issuing Activity.

Variations of the phase of the maximum water wave force on a structure are discussed. Physical separation of structural members, differences in member diameter, shed vortices and wave randomness are analyzed. A distinction is made in function of the member size (Kenlegan-Carpenter member), for members that are large in diameter relative to wave height. The forces are dominated by inertia effects and the maximum force is in phase with particle acceleration. As members become smaller drag forces are predominant. The phase difference between the maxima of the two cases is 90 deg. The use of the Morison equation to obtain a total force from the combination of drag and inertia forces is illustrated. It is shown that time variation of these forces is very sensitive to small changes from one half cycle to another, suggesting a statistical approach to provide a logical basis for design.

5441 **(N—8327254) Wave forces on circular cylinders with large excrescences at low Keulegan and Carpenter numbers.** Singh, S. (Lloyd's Register of Shipping); Cash, R. (National Maritime Inst., Feltham (UK)). Mar 1982. 72p. (NMI-R—133). Issuing Activity.

A program to assess the effect of large excrescences on wave loading of circular cylindrical members is presented. This involves the testing in waves of vertical cylinders fitted with rack teeth, and horizontal and vertical cylinders fitted with sacrificial anodes. Results for both forms of excrescences suggest that high loads can be produced under certain conditions (up to four times those on a smooth cylinder, when rack teeth are fitted), notably when the excrescences are at large angles of incidence.

5442 **(N—8327255) A comparison of two methods for calculating wave drift forces.** Brendling, W.J. (National Maritime Inst., Feltham (UK)). Feb 1982. 14p. (NMI-R—137). Issuing Activity.

Two computer programs used to calculate wave drift forces in offshore structures are compared. The NMIWAVE program, was developed to calculate second order, slowly varying, wave drift forces. It is based on a Stokes series expansion of the wave forces. The first order product terms are evaluated exactly using the results of first order diffraction programs. The second order potential term, however, is only approximated. In the second program, using the techniques of Lagrangean mechanics, computable expressions for the exact second order drift force subject to the rigid lid condition were developed. For freely floating structures with small waterplane areas, which only slightly disturb the surface of long waves, the Lagrangean method represents an advance over the Stokes expansion. For the example considered, an offshore storage terminal, the rigid lid approximation appears to be valid for the first order solution. The comparison of the second order drift forces is somewhat inconclusive, because these forces are dominated by the second order potential which NMIWAVE only approximates. The two methods are probably complementary in the sense that their regimes of validity are almost mutually exclusive.

5443 **Stochastic analysis and probabilistic prediction of random seas.** Ochi, M.K. (Department of Coastal and Oceanographic Engineering, University of Florida, Gainesville, Florida). *Advances in Hydroscience;* **13**: 218-375(1982).

This work is intended to provide information necessary for understanding statistical prediction of the properties of random seas. A mathematical description is given of random seas and the basic principles are given pertinent to the stochastic approach. Prediction methods are given for wave height and period respectively. Spectral formulations are given of wind-generated seas that can be used for predicting responses of Marine systems and offshore structures. Finally, a discussion is given of the directional distribution of wave energy, which is one of the most important factors for representing confused seas.

64 PHYSICS RESEARCH

6401 Astrophysics And Cosmology

REFER ALSO TO CITATION(S) 5485

5444 **(INPE—1665) Nuclear gamma ray lines from supernovae.** Jardim, J.O.D. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Jan 1980. 13p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703849.

From theoretical considerations of the behaviour of gamma ray line fluxes occurring after a supernova explosion, the 1.156 and 0.847 MeV lines are seen to be the most likely to be observed. The 1.156 MeV line has been previously observed by other investigators. Observations of the 0.847 MeV line, and 1.332, 1.173 and 0.059 MeV lines using a Ge(Li) telescope aboard a stratospheric balloon which was flown in Brazil in 1977 are reported. The observation using a NaI(Tl) detector of a line in the energy interval 1.5 - 1.6 MeV, which may be due to 0^{18} (p,p') 0^{18} sup (*) reaction is also reported.

5445 **(INPE—2004) Measurement of the 0.511 MeV γ ray line from the galactic center.** Jardim, J.O.D.; Benson, J.L.; Jardim, M.V.A.; Martin, I.M. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Feb 1981. 10p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703851.

The detection of the 0.511 MeV electron-positron annihilation line coming from the Galactic Center can provide the means to estimate the rate of positron production and to test some theoretical sources of positrons. The result of the measurements of the

0.511 MeV line flux made in a gamma-ray experiment on board a stratospheric balloon is presented. The detector field of view looked at the galactic longitude range-31° <l sup (II) < +41°. The observed flux is (6.70 + - 0.85)x10^{-3} photons cm^{-2} s^{-1}, which is in good agreement with the expected flux when assuming that the Galactic Center is a line source emitting uniformly.

5446 **(INPE—2438) Gamma radiation measurement, through a spark chamber put aboard a stratospheric balloon.** Santo, C.M.E.; Rao, K.R. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Jun 1982. 26p. (In Portuguese). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703853.

For determining the diffuse component of gamma rays in the 15 to 75 Mev range arriving from near the galactic center, a digitized spark chamber was launched aboard two balloons from Resende, Brazil, on 19 November and 3 December 1975. In each flight the detector reached an altitude of 2,2 g/cm^2. Based on these data, a diffuse gamma ray flux 6,0x10^{-5}, 2,0x10^{-5}, 4,6x10^{-6} and 1,3x10^{-6} photons (cm^2.s.sterad.Mev) at energies of 21, 36, 52, 67 Mev respectively was obtained. These values give a power law spectrum with spectral index equal to -3,3. The dependence of this radiation with the galactic latitude and longitude in the interval -5° < = b sup(II) < = 35° and 325° < = l sup(II) < = 375° was also obtained. Finally, our results were compared with other experiments' results.

5447 **(UCRL—89582) Synthetic H-R diagrams as an observational test of stellar evolution theory.** Mathews, G.J.; Becker, S.A.; Brunish, W.M. (Lawrence Livermore National Lab., CA (USA); Los Alamos National Lab., NM (USA)). Jul 1983. Contract W-7405-ENG-48. 10p. (CONF-8305150—1). NTIS, PC A02/MF A01. Order Number DE84002796.

From Advanced School of Astronomy workshop on stellar nucleosynthesis; Erice, Italy (11 May 1983).

Synthetic H-R diagrams are constructed from a grid of stellar models. These are compared directly with observations of young clusters in the LMC and SMC as a test of the models and as a means to determine the age, age dispersion, and composition of the clusters. Significant discrepancies between the observed and model H-R diagrams indicate the possible influences of convective overshoot, large AGB mass-loss rates, and the best value for the mixing length parameter.

5448 **(UCRL—89841) Nucleosynthesis in stellar explosions.** Woosley, S.E.; Axelrod, T.S.; Weaver, T.A. (California Univ., Santa Cruz (USA); Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 37p. (CONF-8309183—1). NTIS, PC A03/MF A01. Order Number DE84002787.

From Erice conference on nucleosynthesis; Erice, Italy (9 Sep 1983).

Portions are illegible in microfiche products.

The final evolution and explosion of stars from 10 M/sub solar/ to 10^6 M/sub solar/ are reviewed with emphasis on factors affecting the expected nucleosynthesis. We order our paper in a sequence of decreasing mass. If, as many suspect, the stellar birth function was peaked towards larger masses at earlier times (see e.g., Silk 1977; but also see Palla, Salpeter, and Stahler 1983), this sequence of masses might also be regarded as a temporal sequence. At each stage of Galactic chemical evolution stars form from the ashes of preceding generations which typically had greater mass. A wide variety of Type I supernova models, most based upon accreting white dwarf stars, are also explored using the expected light curves, spectra, and nucleosynthesis as diagnostics. No clearly favored Type I model emerges that is capable of simultaneously satisfying all three constraints.

5449 **(UWThPh—83-06) Bosonic black holes.** Thirring, W. (Vienna Univ. (Austria)). 1983. 5p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703856.

The gravitational collapse of bosonic matter leads to small black holes. Their properties and physical effects are discussed.

5450 **Theory of bending waves with applications to disk galaxies.** Mark, J.W.K. (Lawrence Livermore National Lab., CA (USA)). pp 289-302 of Kinematics, dynamics and structure of the Milky Way. Proceedings of a workshop held in Vancouver, Canada, May 17-19, 1982. Shuter, W.L.H. (ed.) (British Columbia Univ., Vancouver (Canada). Dept. of Physics). Dordrecht, Netherlands; D. Reidel (1983). (CONF-8205108—).

From UBC-UM conference on the milky-way; Vancouver, BC, Canada (17 May 1982).

Includes subject index.

A theory of bending waves is surveyed which provides an explanation for the required amplification of the warp in the Milky Way. It also provides for self-generated warps in isolated external galaxies. The shape of observed warps and partly their existence in isolated galaxies are indicative of substantial spheroidal components. The theory also provides a plausible explanation for the bending of the inner disk (< 2 kpc) of the Milky Way.

6402 Atmospheric Physics

5451 **(INPE—1888) Spectral observations of atmospheric γ-ray background.** Jayanthi, U.B.; Blanco, F.G.; Aguiar, O.D. de; Jardim, J.O.D.; Benson, J.L.; Martin, I.M.; Rao, K.R. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). May 1981. 5p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703850.

Based on the results of two balloon flights, made at Sao Jose dos Campos and at Juazeiro do Norte in Brazil, using omnidirectional gamma ray detectors, the different aspects of atmospheric gamma rays at equatorial latitudes in the energy interval of 0.3 to 4.5 MeV are investigated. The energy loss spectrum in this energy band is found to consist of a continuum and a photo peak at 0.51 MeV in agreement with previous observations. A discussion of the spectral nature of this background and the observed lower intensities of both the continuum and the 0.51 MeV line with reference to observations at other latitudes is presented.

5452 **(INPE—2119) Particle precipitation and atmospheric X-and gamma-rays in the South Atlantic magnetic anomaly by balloon experiments.** Costa, J.M. da. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Jun 1981. 8p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703852.

Studies concerning particle precipitation and atmospheric X- and low energy gamma-rays in the South Atlantic magnetic anomaly by balloon experiments that have been made at INPE since 1968 are reported.

5453 **(TRITA-EPP—82-05) Physics of relativistic double layers.** Carlqvist, P. (Royal Inst. of Tech., Stockholm (Sweden). Electron and Plasma Physics). Jun 1982. 32p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83703854.

A model of a strong, time-independent, and relativistic double layer is studied. Besides double layers having the electric field parallel to the current the model also describes a certain type of oblique double layers. The 'Langmuir condition' (ratio of ion current density to electron current density) as well as an expression for the potential drop of the double layer are derived. Furthermore, the distribution of charged particles, electric field, and potential within the double layer are clarified and discussed. It is found that the properties of relativistic double layers differ substantially from the properties of corresponding non-relativistic double layers.

6403 Atomic, Molecular, And Chemical Physics

REFER ALSO TO CITATION(S) 5351, 5472

5454 **(CONF-8308112—4) Temperature and pressure dependence of the nondissociative electron attachment to perfluoropropylene (1-C_3F_6).** McCorkle, D.L.; Christophorou, L.G.; Hunter, S.R. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy). 1983. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01. Order Number DE84003383.

From 3. international Swarm seminar; Innsbruck, Austria (3 Aug 1983).

Portions are illegible in microfiche products.

Earlier investigations of electron attachment to 1-C_3F_6 in dilute gas mixtures of 1-C_3F_6 with the buffer gases N_2 and Ar have shown an anomalous dependence of the electron attachment rate constant, k/sub a/, for 1-C_3F_6 on both the buffer, N/sub B/, and attaching, N/sub A/, gas number density. These studies also showed that the k/sub a/ decreases significantly with increasing temperature T (300 to 473K). These findings, as well as additional measurements of k/sub a/(T) at T<300K, are presented and discussed in this paper.

5455 **(DESY-SR—83-03) Calculated photoemission spectra of the 5f states in the actinides.** Gerken, F.; Schmidt-May, J. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Feb 1983. 30p. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.).

The complex multiplet structure of the partially filled 5f shell in the Actinides is calculated in intermediate coupling. The obtained eigenfunctions are used for a calculation of photoemission intensities in the fractional parentage scheme including all final states. The obtained calculated spectra are significantly different from the equivalent results for the 4f states in the Rare Earth metals presented recently.

5456 **(DOE/ER/06043—T1) Stored ion collision measurements. Final report, September 1, 1978-August 31, 1981.** Church, D.A. (Texas A and M Univ., College Station (USA). Dept. of Physics). Nov 1981. Contract AS05-78ER06043. 20p. NTIS, PC A02/MF A01. Order Number DE84002155.

The research as originally proposed was a planned investigation and demonstration of a stored multi-charged ion measurement technique based on the Penning trap. The multi-charged ions were to be produced by electron impact ionization of gases or beam atoms in the trap. The ions were to be stored under ultra-high vacuum conditions. Unwanted ion m/q ratios were to be removed by resonant excitation. The ion number was to be detected by resonant energy absorption. The proposed measurements to be investigated for feasibility were (a) ion-molecule charge transfer rate constant measurements, (b) electron impact ionization of ions, and (c) electron impact excitation of ions, with detection of emitted photons. During the first project year, it was learned at the DOE Contractors Meeting that the Fundamental Interactions Branch was funding theoretical research by Professor A. Dalgarno directed toward calculation of near-thermal charge-transfer from H atoms to multi-charged ions. It was subsequently proposed to devote major attention to topic (a), above, under which collisions of this type were characterized, in order to provide an experimental test of this theory. Further, topic (c), above, was modified to additionally detect photons emitted following charge transfer to excited states, which were also predicted by the theory. During the third contract year, it was proposed to demonstrate measurements of a rate constant for charge transfer from H and H_2 to multi-charged ions.

5457 **(DOE/ER/10618—9) Computational spectroscopy.** Fischer, C.F. (Vanderbilt Univ., Nashville, TN (USA)). 1983. Contract AS05-80ER10618. 2p. (CONF-830936—3). NTIS, PC A02/MF A01. Order Number DE84003754.

From Symposium on atomic spectroscopy (SAS-83); Berkeley, CA, USA (12 Sep 1983).

The prediction, through computation, of atomic properties pertaining to energy levels and transitions might be viewed as Computational Spectroscopy. It is useful to distinguish such activities from theory since often no new, fundamental theories are developed. Like experimental spectroscopy, computational spectroscopy is a tool for the study of atomic spectra, a tool that still needs considerable refinement. In this paper, several types of calculations will be discussed and progress in computational procedures described.

5458 **(INIS-mf—8428) Theory of the quasimolecular K-X radiation in the example of the Ni-Ni system.** Peitz, H. (Frankfurt Univ. (Germany, F.R.). Fachbereich Physik). 13 Jul 1981. 72p. (In German). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703258.

Thesis (Ph.D.).

The K-X-ray spectra and anisotropies for the Ni-Ni-system have been calculated for the laboratory energies 30, 60 and 90 MeV. Two-Center-Dirac energies for the three inner shells have been used and the radial, rotational and radiative matrix elements have been calculated. For the radiative matrix elements the long wave-length limit was applied. Coupled channel calculations were used to calculate the ionization amplitudes. It is shown, that within reasonable numerical calculations translation effects can not be incorparated in the radial matrix elements. Therefore radial coupling was neglected. In the calculations shown here, the K-shell was assumed to be empty. The influence of the rotational contribution to spectra and anisotropies has been studied. Comparison with experimental results shows, that the exponential decrease of the spectra is too small for high photon energies. Like in experiment, the calculated anisotropies show a bump close to the Ksub(α)-energy of the united system.

5459 **(SRD-R—253) Preliminary analysis of the thermodynamics of gas atoms in very small bubbles.** Winter, P.W.; MacInnes, D.A. (UKAEA Safety and Reliability Directorate, Culcheth). Dec 1982. 16p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703842.

Using analytic techniques it is shown that the thermodynamics of gas in very small bubbles shows marked deviation from that anticipated by applying the thermodynamics of a macroscopic fluid to gas in small bubbles. The significance of these deviations is discussed in the light of the predicted importance of thermal resolution from bubbles to the lattice in the evolution of fission gas.

5460 **(UCRL—89586) De-excitation and equipartition in H_2-surface collisions.** Karo, A.M.; Hiskes, J.R.; Olwell, K.D.; DeBoni, T.M.; Hardy, R.J. (Lawrence Livermore National Lab., CA (USA); Nebraska Univ., Lincoln (USA)). Nov 1983. Contract W-7405-ENG-48. 10p. (CONF-831180—2). NTIS, PC A02/MF A01. Order Number DE84003008.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

We have used computer molecular dynamics to study de-excitation of vibrationally-excited H_2 molecules undergoing repeated collisions with a wall maintained at some temperature T(W). We have calculated the average loss or gain of vibrational, rotational, translational, and total molecular energy as a function of the number of collisions for a statistically significant number of molecules having some initial vibrational state v'' ranging from v'' = 2 to v'' = 12. For initial translational and rotational temperatures around 500°K, we have obtained a consistent picture of rapid vibrational de-excitation during the first collision, with a corresponding increase in translational kinetic energy and with rotational excitation from an initial J = 1 state up through values greater than J = 14. Wall collisions are found to provide an effective and rapid kinematic mechanism for V-T, V-R, and R-T energy transfer. The rate of loss of total molecular energy to the wall (accommodation) is discussed and compared with the rate of energy redistribution (equipartition) among the vibrational, rotational, and translational degrees of freedom of the molecules.

5461 Electron capture cross sections for low velocity Ne /SUP q+/ (q=2, 3, 4, 5 & 6) incident upon atomic hydrogen. Gray, T.J.; Can, C.; Hall, J.M.; Tunnell, L.; Varghese, S.L. (Kansas State Univ., Manhattan, KS 66506). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **30**: No. 2, 895-897(Apr 1983).

Measurements of electron capture cross sections for low velocity Ne /SUP q+/ ions (q = 2, 3, 4, 5 & 6) in collisions with atomic hydrogen are discussed. The Ne ions are obtained from a recoil ion source using a F^{4+} pump beam from the EN tandem accelerator. Time-of-flight techniques and post interaction electrostatic analysis provide for the experimental determination of the electron capture cross sections. Comparisons to theories are presented.

5462 Low-energy inelastic collisions of multiply charged ions with electrons and hydrogen atoms. Phaneuf, R.A.; Crandall, D.H. (Oak Ridge National Lab., TN (USA)). *Physica Scripta;* **T3**: 131-134(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

The authors report the status of current studies, primarily at ORNL, on low energy inelastic collisions of multicharged ions. A few specific measurements and theoretical predictions, which are discussed in other publications, are cited to illustrate present levels of understanding. Recent cross section measurements are presented for ionization of multiply charged ions by electron impact, and for electron capture by multiply charged ions from hydrogen atoms at low energies. For the alkali-like transition-series ions, Ti^{+3}, Zr^{+3}, and Hf^{+3}, the excitation of an inner-shell electron, followed by autoionization (excitation-autoionization) dominates the total electron-impact ionization cross-section by more than an order of magnitude. For electron capture, the total cross-sections for Csup(+q) + H and Osup(q+) + H collisions (3<=q<=6) have been measured at energies ranging from 10-700 eV amu^{-1}. For these few-electron systems at low energies, the capture cross-sections do not scale with ionic charge, or vary uniformly with velocity. Where detailed theory is available, agreement is generally satisfactory.

5463 Collisions of fast highly charged ions in gas targets: ionization recoil-ion production and charge transfer. Schlachter, A.S.; Berkner, K.H.; Pyle, R.V.; Stearns, J.W. (Lawrence Berkeley Lab., CA (USA)); Beyer, H.F.; Mann, R. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)); Graham, W.G. (New Univ. of Ulster, Coleraine (UK)); Groh, W.; Mueller, A. (Giessen Univ. (Germany, F.R.). Inst. fuer Kernphysik); Olson, R.E. (Missouri Univ., Rolla (USA). Dept. of Physics). *Physica Scripta;* **T3**: 153-158(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

Electron-capture, ionization, and recoil-ion-production cross-sections are measured and calculated for fast highly charged projectiles in hydrogen and rare-gas targets. Recoil-ion-production cross-sections are found to be large; the low energy and high charge states of the recoil ions make them useful for subsequent collision studies.

5464 Experiments with highly ionized low-energy tandem accel-decel beams. Jones, K.W.; Johnson, B.M.; Meron, M.; Da-Hai, W.; Thieberger, P.; Barrette, J.; Schuch, R.; Schmidt-Boecking, H.; Tserruya, I.; Kruse, T.H. (Brookhaven National Lab., Upton, NY (USA)). *Physica Scripta;* **T3**: 182-184(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

The present status of the production of low-energy highly ionized beams by the 4-stage tandem accel-decel method is surveyed, and their use in three atomic physics experiments is summarized. The experiments are: the measurement of the charge state dependence of K-X-ray production in Ssup(+q)-Ar collisions at 10 MeV, the impact-parameter dependence of quasimolecular X-rays in S^{+15}-Ar collisions at 10 MeV, and the determination of charge transfer cross sections in Ssup(+q) + Ar, He collisions. The results of the three experiments give evidence that the 4-stage accel-decel ion production technique is extremely powerful and useful.

5465 Effects of autoionizing levels in highly ionized atoms. Cowan, R.D. (Los Alamos National Lab., NM (USA)). *Physica Scripta;* **T3**: 200-207(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

A review is given of the contribution of autoionizing levels to photoionization, collisional ionization, dielectronic recombination, and collisional excitation, all based on a simple approach involving only perturbation-theory calculation of autoionization and radiative transition probability rates. Numerical examples are treated for dielectronic-recombination contributions to observed 2p-3d spectra in Mo^{29+} to Mo^{33+}, and for resonance contributions to 2s-3s and 2p-3s collision strengths in O^{5+}.

5466 Interactions of multiply charged ions with solids. Datz, S. (Oak Ridge National Lab., TN (USA)). *Physica Scripta;* **T3**: 79-87(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

Three types of low-energy interactions of multiply charged ions with solids are discussed. First the interactions of high-energy highly stripped ions moving in channels which interact only with conduction electrons and hence participate in collisions with greatly reduced center-of-mass energies. Second, charge capture to multiply charged recoil ions formed in solids by collisions of high-energy multiply charged ions. Third, effects which may occur when low-energy multiply charged ions are scattered from surfaces.

5467 Dynamical calculations with the off-shell Coulomb T-matrix. Catalan de Munoz, G. Stirling, Scotland; Stirling University (1981). 182p. British Library, Boston Spa, Wetherby, West Yorks. No. D42864/82.

Thesis (Ph.D.).

This thesis is concerned with the application of the Faddeev=-Watson multiple scattering expansion to electron-atom collisions. The basic formulism is presented together with a discussion on the off-shell Coulomb T-matrix which is the principal dynamical ingredient in the Faddeev-Watson approximation. Simplifications to the first and second order terms of the expansion are derived, which are valid for high momentum transfers of the incident particle. The connection between the Born and Faddeev-Watson approximations is discussed. The results are applied to the elastic and inelastic scattering of electrons on atomic hydrogen and to the electron impact excitation of Helium. Exchange processes are not considered.

5468 Experimental study of the interactions of positrons and electrons in gases. Charlton, M. London, England; London University (1980). 175p. British Library, Boston Spa, Wetherby, West Yorks. No. D36677/81.

Thesis (Ph.D.).

The slow positron beam apparatus, employing a localised scattering cell has been used to measure total scattering cross sections for the molecular gases hydrogen, nitrogen, oxygen, carbon dioxide and methane in the energy range 15-600 eV, electron-helium and electron-argon total scattering cross sections in the energy range 2-50eV. A study of the variation of the scattering cell normalisation constant, k, has been carried out. Gamma-rays produced in the annihilation of ortho-positronium formed in a gas cell remote from the positron source have been detected and the efficiency of ortho-positronium formation measured as a function of the beam energy. The gases helium, argon, hydrogen and methane have been studied. Some discussion of a method of using these measurements to deduce absolute positronium formation cross sections is given. A new positron moderator with up to ten times the conversion efficiency of magnesium oxide is described. (author).

5469 Electron impact excitation of helium atoms. Hollywood, M.T. Belfast, Northern Ireland; Queen's University (1979). 189p. British Library, Boston Spa, Wetherby, West Yorks. No. D36614/81.

Thesis (Ph.D.).

Two experiments have been conducted in an apparatus which was designed and constructed to study interactions between electrons and atoms. (1) The polarisation fraction of the ultraviolet

radiation emitted following electron impact excitation of the n^1P states of helium atoms has been deduced from measurements of the angular distribution of the photons for incident electron energies from 40eV to 300eV. (2) Angular correlations between the scattered electrons resulting from the excitation of the 2^1P state of helium and the photons emitted in the decay of this state have been measured using the delayed coincidence technique for an incident energy of 81.2eV. The measurements extend over the electron scattering angles from 10 deg to 130 deg.

5470 **Some collisions involving the formation and destruction of H^- ions and excited states of hydrogen.** Hill, J. Belfast, Northern Ireland; Queen's University (1979). 233p. British Library, Boston Spa, Wetherby, West Yorks. No. D36613/81.

Thesis (Ph.D.).

Cross sections for the formation of H(2s) atoms in collisions of H^+, H(1s) and H^- with H and H_2 have been determined within the energy range 1.5 to 30 keV. A tungsten tube furnace has been used to provide a target of highly dissociated hydrogen. The formation of H(2p, 2s, 3s, 3d) atoms in 3 to 25 keV collisions of H^- with He, Ne, Ar, N_2 and H_2 has been investigated. A modulated beam technique has been used to investigate total destruction, electron capture and loss by 5 to 26 keV H(2s) atoms in H and H_2. Measurement of electron capture and excitation cross sections for 4 to 26 keV H(2s) atoms in He, Ne, Ar, Kr, N_2 and H_2 has also been made. The growth of Lyman-α and Balmer-α radiation as a function of target thickness has been used to determine collisional destruction cross sections for 5 to 25 keV H(2p, 3s, 3d) atoms in collisions with He, Ar and N_2. One- and two- electron loss by 1 to 30 keV H^- ions in H and H_2 has been investigated and the results are compared with a number of theoretical estimates.

5471 **Electron scattering through thin foils.** King, T.C.F. Belfast, Northern Ireland; Queen's University (1979). 153p. British Library, Boston Spa, Wetherby, West Yorks. No. D36619/81.

Thesis (Ph.D.).

The results are presented of an investigation of the momentum space wave function of carbon atoms carried out using the technique of symmetric high energy electron impact ionization (e, 2e) of thin solid targets. With E_0 the incident electron energy either 6 or 8 keV, $E_1 = E_0/2$ and theta = 45 deg and using both pure carbon and Formvar targets, the presence of two peaks in a binding energy scan was found.

6404 Fluid Physics

5472 **(DOE/PC/50800—T4) Transport and relaxation processes in supercritical fluids. Technical progress report, July 1-October 1, 1983.** Jonas, J. (Illinois Univ., Urbana (USA). Dept. of Chemistry). 1983. Contract FG22-82PC50800. 7p. NTIS, PC A02/MF A01. Order Number DE84002182.

Since the submission of the last progress report we attempted to finish the interpretation of transport data on supercritical ethylene and ethylene-CO_2 mixtures. The experimental work focused on measurement of transport in supercritical toluene; building of high pressure densitometer for supercritical fluids and laser scattering experiments on supercritical methane. Work also continued on testing of the NMR setup for solubility measurements of solids in supercritical fluids.

6450 High Energy Physics

5473 **Trends in experimental high-energy physics.** Sanford, T.W.L. (Los Alamos National Laboratory, Los Alamos, New Mexico). *Technological Forecasting and Social Change;* **23**: No. 1, 25-39(Mar 1983).

Data from a scan of papers in Physical Review Letters and Physical Review are used to demonstrate that American high-energy physicists show a pattern of accelerator and instrumentation usage characteristic of that expected from the logistic-substitution model of Marchetti and of Fischer and Pry.

6451 Particle Interactions And Properties - Experimental

REFER ALSO TO CITATION(S) 5492, 5493

5474 **(ANL-HEP-CP—83-59) D* and D meson production in e^+e^- annihilation at 29 GeV.** Loos, J.S. (Argonne National Lab., IL (USA)). Aug 1983. Contract W-31-109-ENG-38. 11p. (CONF-8308131—3). NTIS, PC A02/MF A01. Order Number DE84003651.

From 3. international conference on physics in collision; Como, Italy (31 Aug 1983).

Recent results on D* and D meson production at 29 GeV are presented from the DELCO, HRS, and MARK II collaborations at PEP.

5475 **(BNL—33750) Measurement of the scaling x and y distributions of neutral and charged current nu/sub μ/ interactions.** Baltay, C.; Bregman, M.; Caroumbalis, D.; Chen, L.D.; French, H.; Hibbs, M.; Hylton, R.; Igo-Kemenes, P.; Liu, J.T.; Okamitsu, J. (Columbia Univ., New York (USA); Brookhaven National Lab., Upton, NY (USA); Rutgers--the State Univ., New Brunswick, NJ (USA)). 1983. Contract AC02-76CH00016. 5p. (CONF-830718—14). NTIS, PC A02/MF A01. Order Number DE84002860.

From International Europhysics conference on high energy physics; Brighton, UK (20 Jul 1983).

We report on a joint study of the neutral and charged current reactions nu/sub μ/ + Ne $\rightarrow$ h + nu/sub μ/ and nu/sub μ/ + Ne h + μ^-. With the aim to obtain distributions in the scaling variables x and y. The experiment was performed at the FNAL narrow band neutrino beam (neutrino energies up to 240 GeV; mean energy: 60 GeV) and used the 15-foot bubble chamber filled with a heavy neon-hydrogen mix (59 atomic percent of neon) to detect neutrino interactions. The narrow band beam allows one to determine the four-momentum of the incoming neutrino from the radial position of the interaction vertex. The bubble chamber, on the other hand, permits one to detect the detailed composition of the final state hadronic system, h, and to reconstruct its four-momentum. From these the four-momentum of the outgoing lepton can be reconstructed on an event-by-event basis. The quality of the lepton reconstruction can be studied on charged current events for the outgoing lepton, the μ^-, is detected. The data sample consists of 950 nu/sub μ/ interaction candidates within a reduced fiducial volume which was chosen to insure a good containment of the hadronic shower and to improve the event reconstruction.

5476 **(BNL—33839) Observation of the anomalous nuclear enhancement in the neutral energy spectrum in the central region of α-α interactions at $\sqrt{s}$ = 124 GeV at the CERN ISR.** Angelis, A.L.S.; Basini, G.; Besch, H.J.; Breedon, R.E.; Camilleri, L.; Chapin, T.J.; Chasman, C.; Cool, R.L.; Cox, P.T.; von Gagern, C. (Brookhaven National Lab., Upton, NY (USA); European Organization for Nuclear Research, Geneva (Switzerland); Michigan State Univ., East Lansing (USA); Oxford Univ. (UK); Rockefeller Univ., New York (USA)). 1983. Contract AC02-76CH00016. 8p. (CONF-8309168—2). NTIS, PC A02/MF A01. Order Number DE84002884.

From 3. international conference on ultra-relativistic nucleus-nucleus collisions; Upton, NY, USA (26 Sep 1983).

Preliminary results are presented for the total neutral energy spectra in the central region from $\alpha\alpha$ and pp collisions at center-of-mass energies of $\sqrt{s}$ = 31 GeV per nucleon pair. (WHK)

5477 (DOE/ER/03274—4, pp 1-74) **Final results from experiment E399H: a study of central collisions of relativistic ^{12}C and ^{40}Ar on ^{208}Pb, using π^{+-} and π^0 production as probes.** Hallman, T.; Madansky, L. 1983. NTIS, PC A07/MF A01.

In Nuclear moments and nuclear structure. Annual progress report, September 1, 1982-August 31, 1983.

A systematic study, as a function of beam energy and charged particle multiplicity, of the rate of neutral pion production in ^{12}C reactions on ^{208}Pb is presented for energies from .4 to 2.1

GeV per nucleon. Data are compared with similar data from $^{40}Ar + ^{208}Pb$ experiments. A description of the experimental apparatus is given and measurement of π^{+-} production and charged particle multiplicity is discussed. 26 references. (KAW)

5478 (DOE/ER/03274—4, pp 75-81) **Particle-gamma coincidence measurements in $^{12}C + ^{12}C$ and ^{12}C + Pb collisions at 2.1 GeV/A incident energy, first results - γ-ray spectrum.** Roche, G. (Universite de Clermont-Ferrand, France); Carroll, J.; Chang, C.C.; Hallman, T.; Kirk, P.N.; Koontz, R.; Krebs, G.; Madansky, L.; Mulera, T.; Pugh, H. 1983. NTIS, PC A07/MF A01.

In Nuclear moments and nuclear structure. Annual progress report, September 1, 1982-August 31, 1983.

The first results from an experiment in which gamma-rays associated with light particles produced in carbon-carbon and carbon-Pb collisions were measured are presented. No evidence for radiative decay of excited particles was found. The gamma rays seem entirely due to the production of pi-zero mesons.

5479 (DOE/ER/05096—13) **High energy physics. Progress report, March 1, 1983 - February 29, 1984.** Phillips, G.C.; Roberts, J.B. Jr. (Rice Univ., Houston, TX (USA). Bonner Nuclear Labs.). 14 Oct 1983. Contract AS05-76ER05096. 71p. NTIS, PC A04/MF A01. Order Number DE84002423.

Our work in High Energy Physics for the 1983-1984 contract year has been concentrated in two major areas: (1) analysis of existing data and preparation for the upcoming run of FNAL E-609, a study of high transverse energy proton-proton and proton-nucleus collisions; and (2) study of the spin dependence of the strong interaction. Considerable effort has been made toward the analysis of the data from the 1982 run of FNAL E-609. These studies include the following: calibration and energy scale of the calorimeter; phase space Monte Carlo studies; Field-Feynman and Field-Feynman-Fox QCD Monte Carlo studies; search for Berger-Brodsky events; and study of proton-nucleus scattering. Preparation for the upcoming data-taking run has also continued. We expect the Rice contribution to the polarized beam acceleration project at the BNL/AGS to continue. We have also transported our polarized proton target PPT VI to the AGS to be used in experiments to develop a very high intensity polarized atomic hydrogen source. Also the agreement has been signed by the Director for the first-round experiments utilizing the Tevatron II polarized beam, FNAL E-704.

5480 (LBL—16724) **Inclusive lepton production in hadronic events from e^+e^- annihilation at 29 GeV.** Nelson, M.E. (Lawrence Berkeley Lab., CA (USA)). Oct 1983. Contract AC03-76SF00098. 202p. NTIS, PC A10/MF A01. Order Number DE84003893.

Portions are illegible in microfiche products; Thesis.

We have measured the production rates of prompt electrons and muons in hadronic events from e^+e^- annihilation at 29 GeV. The inclusive rate per hadronic event for leptons with total momenta greater than 2 GeV/c is determined to be (0.033 +- 0.003 +- 0.012) for electrons and (0.037 +- 0.005 +- 0.008) for muons. We measure the longitudinal and transverse momentum spectra of these leptons. The harder transverse momentum spectrum of leptons from bottom and charm quark relative to charm decays allows us to separate the bottom and charm quark contributions to the prompt lepton signal. The longitudinal momentum distributions allow us to study the fragmentation properties of these heavy quarks. For charm quarks we find average semileptonic branching ratios of (6.4 +- 1.3 +- 2.8)% into electrons and (8.1 +- 1.6 +- 1.8)% into muons. For bottom quarks we find average branching ratios of (12.9 +- 2.5 +- 2.0)% into electrons and (12.2 +- 5.0 +- 3.0)% into muons. The fragmentation function for bottom quarks is determined to be peaked at large z with <z>/sub b/ $\simeq$ 0.75. 46 references.

5481 (RL—82-081) **Hadron final state results from BEBC.** Cooper, A.M. (Science Research Council, Chilton (UK). Rutherford and Appleton Labs.). Oct 1982. 8p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703858.

Antineutrino-nucleon, neutrino-proton and antineutrino-proton interaction results, obtained from BEBC experiments, are reported.

5482 (SLAC-PUB—3197) **Recent results from SPEAR.** Wacker, K. (Stanford Linear Accelerator Center, CA (USA)). Sep 1983. Contract AC03-76SF00515. 14p. (CONF-830374—4). NTIS, PC A02/MF A01. Order Number DE84002032.

From Moriond conference on electroweak interactions; Les Arcs, France (13 Mar 1983).

The first part of this talk is an experimental review of the properties of the Θ meson. Results or upper limits come from radiative j/psi decays and $\gamma\gamma$ scattering for the final states eta eta, $\pi\pi$, K anti K and rho rho. In the second part, an upper limit is given for the production of low-mass particles in radiative J/psi decays. Constraints for the existence of low-mass gluonic and Higgs mesons are derived.

6452 Particle Interactions And Properties - Theoretical

REFER ALSO TO CITATION(S) 5533

5483 (DOE/ER/40033—B-55) **High energy physics. Technical progress report, November 1, 1982 - October 25, 1983.** Beg, M.A.B.; Khuri, N.N.; Pais, A. (Rockefeller Univ., New York (USA)). 1983. Contract AC02-81ER40033. 19p. NTIS, PC A02/MF A01. Order Number DE84002946.

Portions are illegible in microfiche products.

Progress is reported in the following areas: quantum field theory, gauge theories, dynamical symmetry breaking, supersymmetry, magnetic monopoles, cosmology and particle physics, and phenomenological studies. 34 publications under this contract are listed. (WHK)

5484 (WIS-PH—82/21) **Bosonization of two-dimensional QCD with flavor.** Cohen, E.; Frishman, Y.; Gepner, D. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Physics). Sep 1982. 9p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703841.

We present the bosonized Hamiltonian for $(QCD)_2$ with flavor. The bosonized theory has non-local momentum-dependent interactions. It is argued that the strong coupling static approximation is unacceptable.

6454 Field Theory

REFER ALSO TO CITATION(S) 5483

5485 (BROWN/HET—516) **GUTs with several generations and without domain walls.** Kang, K. (Brown Univ., Providence, RI (USA). Dept. of Physics). 1983. Contract AC02-76ER03130. 7p. (CONF-8308139—1). NTIS, PC A02/MF A01. Order Number DE84001291.

From 9. Hawaii topical conference in particle physics; Honolulu, HI, USA (11 Aug 1983).

Grand unified theories (GUTs) have resulted in several exciting cosmological consequences such as the existence of the baryon number violating interactions, the existence of magnetic monopoles and the existence of a phase transition with the critical temperature corresponding to the energy of unification scale. When one applies GUTs to the early universe within the context of the standard big bang scenario, classic puzzles like the matter-antimatter asymmetry, the large scale homogeneity (beyond the particle horizon) and isotropy of the universe, and the flatness of the present universe may even be answered. In other words cosmology provides possible testing ground for GUTs that are not available from laboratory experiments. Recent developments concerning the invisible axion promote this view even further. One cosmological implication of the invisible axions in GUTs is discussed: the requirement of no domain-wall structures in the early universe and the generation problem of flavors. (WHK)

5486 (INIS-SU—168, pp 3-21) **Two-dimensional exactly and completely integrable dynamical systems.** Leznov, A.N.; Saveliev, M.V. 1982. NTIS (US Sales Only), PC A17/MF A01. (CONF-820778—Vol.1).

From 5. international seminar on high energy physics and field theory; Protvino, USSR (12 Jul 1982).

A general scheme is proposed for the construction of exactly and completely integrable dynamical systems in two-dimensional space associated with an arbitrary graded Lie algebra and with the definite-type embeddings of three-dimensional subalgebra A_1. A group method is used to find general solutions to these systems. Information is given about the embeddings of 3D-subalgebra in an arbitrary Lie algebra. Its multiplet structure in accordance with A_1 is described. An explicit form for exactly and completely integrable systems under consideration is given. The Hamilton formalism is presented for these systems. Exact solutions of the corresponding systems are constructed.

5487 (INIS-SU—168, pp 115-124) **New approach to the measure in the Euclidean field theory.** Alfaro, V. 1982. NTIS (US Sales Only), PC A17/MF A01. (CONF-820778—Vol.1).

From 5. international seminar on high energy physics and field theory; Protvino, USSR (12 Jul 1982).

A method able to determine in a simple way the invariance properties of the measure of an Eucledean generating functional has been introduced. In particular, the well-known results of chiral and gauge theories follow immediately from the suggested prescription and from the requirements of chiral or gauge invariance. It is pointed out that the requirement of conformal invariance for a scalar theory leads to a measure different from the one obtained via canonical treatme.

5488 (INIS-SU—168, pp 149-157) **Geometrical theory of the relativistic string in t=tau gauge.** Barbashov, B.M.; Nesterenko, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1982. NTIS (US Sales Only), PC A17/MF A01. (CONF-820778—Vol.1).

From 5. international seminar on high energy physics and field theory, Protvino, USSR (12 Jul 1982).

It is shown that the world surface of the free relativistic string in t=tau gauge can be described by one linear equation on the scalar function psi(u^1, u^2), u^1=t (u-is a variable). The classical theory of the relativistic string in the t=tau gauge is formulated using the method of the Co-moving frame and the exterior differential forms in the surface theory. The moving frame on the string world surface is chosen in a special form (linear quadratic).

5489 **(RIG—14) Application of the Williams-Weizsaecker-method to higher order S-matrix-approximations.** Ziegelbecker, R.C. (Reaktorinstitut Graz (Austria). Verein zur Foerderung der Anwendung der Kernenergie). May 1983. 19p. (In German). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703857.

In this paper the method of quasireal processes is investigated using a special example - pair production in the stationary field of a nucleus by an incident electron. As a result, the semi-classical version of the Williams-Weizsaecker-method is confirmed on the basis of all 3sup(rd)-order Feynman-diagrams. The spectra of quasireal processes, derived from quantum field theory, can also be applied simultaneously in several vertex points on one diagram and are valid for higher photon energies than the semiclassical spectrum; the restriction $\omega << E$, however, not being required for the application of the Williams-Wiezsaecker-method in the case of only one Feynman-diagram considered, appears to be necessary if more than one Feynman-diagram is needed for the comprehension of the process. Not considered in this paper are processes exceeding possible consequences of the CPT-theorem.

5490 **Topics in quantum chromodynamics.** Pritchard, D.J. Cambridge, England; Cambridge University (1980). 148p. British Library, Boston Spa, Wetherby, West Yorks. No. D41069/82.

Thesis (Ph.D.).

A number of hard scattering processes are calculated and discussed in the framework of the covariant parton model plus perturbative QCD. Various calculational techniques are employed and compared. The main processes looked at are deep inelastic scattering, the pion formfactor and elastic scattering.

5491 **Aspects of scalar fields in gauge theories.** Paterson, A.J. Southampton, England; Southampton University (1980). 134p. British Library, Boston Spa, Wetherby, West Yorks. No. D36647/81.

Thesis (Ph.D.).

Aspects of scalar fields in gauge theories are examined including; scalar Higgs particle production in e^+e^- experiments, the scalar field effective potential, the Coleman-Weinberg phenomenon, phase transitions in gauge theories, and field theories of surfaces.

65 PHYSICS RESEARCH

6510 Nuclear Physics

5492 **(DOE/ER/03274—4) Nuclear moments and nuclar structure. Annual progress report, September 1, 1982-August 31, 1983.** Madansky, L.; Lee, Y.K. (Johns Hopkins Univ., Baltimore, MD (USA)). 1983. Contract AC02-76ER03274. 149p. NTIS, PC A07/MF A01. Order Number DE83017104.

Portions are illegible in microfiche products.

Separate abstracts were prepared for papers from this report on activities of Johns Hopkins University from September 1, 1982 to August 31, 1983. (KAW)

5493 **(DOE/ER/03948—15) Pion interactions at medium energies. Progress report, December 1, 1982-January 31, 1984.** Mayes, B.W. II; Hungerford, E.V. III. (Houston Univ., TX (USA). Dept. of Physics). Oct 1983. Contract AS05-76ER03948. 40p. (ORO—3948-15). NTIS, PC A03/MF A01. Order Number DE84002835.

Portions are illegible in microfiche products.

Research summaries are given on the following topics: spin dependence of nucleon-nucleon amplitudes, kaon and hypernuclear physics, kaon reactions at higher momentum, anti-nucleon reactions, and double charge exchange with heavy ions. A feasibility study for a 1 to 2 GeV separated kaon beam at the AGS is included. Publications are listed. (WHK)

5494 **Neutron streaming analysis for shield design of the fusion materials irradiation test facility.** Carter, L.L. (Hanford Engineering Development Laboratory, Richland, Washington). *Nuclear Technology/Fusion;* 2: No. 2, 286-300(Apr 1982).

Applications of the Monte Carlo method have been summarized relevant to neutron streaming problems of interest in the shield design for the fusion materials irradiation test facility. An improved angular biasing method has been implemented to further optimize the calculation of streaming, and this method has been applied to calculate streaming within a double bend pipe.

6511 Experimental Techniques

REFER ALSO TO CITATION(S) 5613

6514 Nuclear Properties And Reactions, A=20-38

5495 **Transition between light- and heavy-ion elastic scattering.** De Vries, R.M. (Rochester Univ., NY (USA). Nuclear Structure Research Lab.); Goldberg, D.A. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy); Watson, J.W. (Manitoba Univ., Winnipeg (Canada). Dept. of Physics); Zisman, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Cramer, J.G. (Washington Univ., Seattle (USA). Nuclear Physics Lab.). pp 91-94 of Proceedings of international symposium on nuclear physics at cyclotron energies [held at] Calcutta, September 14-16, 1977. Calcutta, India; Bhabha Atomic Research Centre (1979). (CONF-770975—).

From International symposium on nuclear physics at cyclotron energies; Calcutta, India (14 Sep 1977).

Elastic scattering from ^{28}Si of 135.1 MeV/ ^{6}Li and 186 MeV ^{12}C ions has been studied. The shapes of the angular distributions and the resultant optical model analyses indicate that ^{6}Li scattering is quite similar to that of light ions, while ^{12}C ions behave like heavier ions. Thus there appears to be a pronounced and quite rapid transition of scattering characteristics with projectile mass.

6515 Nuclear Properties And Reactions, A=39-58

5496 **(DOE/ER/02785—1) Compilation of information on the energy levels of the light nuclei. Progress report, January 1 - December 31, 1983.** Ajzenberg-Selove, F. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 18 Nov 1983. Contract AC02-76ER02785. 6p. NTIS, PC A02/MF A01. Order Number DE84003173.

Progress on nuclear reaction and nuclear structure studies is briefly reported. Reactions studied are (t,^{3}He) reactions on various targets. (WHK)

5497 (DOE/ER/03496—78, pp 61-104) **Charge and mass exchange in ^{56}Fe-induced reactions at 8.3 MeV/nucleon.** Breuer, H. (Maryland Univ., College Park); Mignerey, A.C.; Viola, V.E.; Wolf, K.L.; Birkelund, J.R.; Hilscher, D.; Huizenga, J.R.; Schroeder, W.U.; Wilcke, W.W. Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Projectile-like fragments from reactions of 465-MeV ^{56}Fe projectiles with targets of ^{56}Fe, ^{165}Ho, ^{209}Bi and ^{238}U have been measured as a function of energy loss, neutron and proton number. The mass and charge of each fragment were uniquely determined with discrete resolution. Data were analyzed as a function of energy-loss by fitting a two-dimensional Gaussian function to the neutron-proton distributions. The fit parameters provide a convenient basis for comparison with theoretical predictions. In addition, centroids and variances derived from more detailed one-dimensional Gaussian fits to isobaric charge distributions are presented. Results are given for measured data as well as for the primary fragment distributions after correction for the dominant neutron evaporation. The centroid data show that in the asymmetric reactions proton transfer from projectile to target nucleus is preferred while the average fragment neuron number is a largely preserved. This produces a charge equilibration process which is dependent on energy-loss within the combined systems. The neutron and proton variances indicate an early dominant neutron flow followed by a constant relative neutron and proton exchange rate at energy losses above about 30 MeV. The degree of correlation of the neutron-proton distributions increases with energy loss and is found to be strongly related to the potential energy surface. Consistently observed negative correlation coefficients at low energy losses suggest the possible importance of processes other than particle exchange in the early stages of the interaction. Variances for constant N, Z and A are found to saturate at energy losses and with magnitudes dependent on the target nucleus.

6516 Nuclear Properties And Reactions, A=59-89

5498 **Neutron resonance study of ^{86}Kr.** Fogelberg, B.; Harvey, J.A.; Macklin, R.L.; Raman, S.; Stelson, P.H. (Oak Ridge National Lab., TN (USA)). pp 411-412 of Neutron-capture gamma-ray spectroscopy and related topics 1981. Egidy, T. von; Goennenwein, F.; Maier, B. (eds.). Bristol, England; Institute of Physics (1982). (CONF-810920—).

From 4. international symposium on neutron-capture gamma-ray spectroscopy and related topics; Grenoble, France (7 Sep 1981).

The level density in ^{87}Kr and the effective capture cross section of ^{86}Kr have been deduced from a neutron resonance study.

6517 Nuclear Properties And Reactions, A=90-149

REFER ALSO TO CITATION(S) 5509, 5516

5499 **(ANL/NDM—81) Covariances for neutron cross sections calculated using a regional model based on local-model fits to experimental data.** Smith, D.L.; Guenther, P.T. (Argonne National Lab., IL (USA)). Nov 1983. Contract W-31-109-ENG-38. 41p. NTIS, PC A03/MF A01. Order Number DE84003213.

We suggest a procedure for estimating uncertainties in neutron cross sections calculated with a nuclear model descriptive of a specific mass region. It applies standard error propagation techniques, using a model-parameter covariance matrix. Generally, available codes do not generate covariance information in conjunction with their fitting algorithms. Therefore, we resort to estimating a relative covariance matrix a posteriori from a statistical examination of the scatter of elemental parameter values about the regional representation. We numerically demonstrate our method by considering an optical-statistical model analysis of a body of total and elastic scattering data for the light fission-fragment mass region. In this example, strong uncertainty correlations emerge and they conspire to reduce estimated errors to some 50% of those obtained from a naive uncorrelated summation in quadrature. 37 references.

5500 **(CONF-821143—11) High-spin properties from energy-energy correlation studies using the spin spectrometer.** Lee, I.Y. (Oak Ridge National Lab., TN (USA)). 1982. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01. Order Number DE84003371.

From High angular momentum properties of nuclei conference; Oak Ridge, TN, USA (2 Nov 1982).

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The continuum γ rays from ^{130}Ce were studied using the spin spectrometer. One-dimensional and two-dimensional spectra were analyzed as a function of angle, spin and entry energy. Spin and temperature dependence of nuclear properties were observed.

5501 (DOE/ER/03496—78, pp 104-167) **Bombarding energy dependence of the ^{144}Sm + ^{84}Kr reaction.** Mignerey, A.C. (Maryland Univ., College Park); Wolf, K.L.; Raich, D.G.; Viola, V.E. Jr.; Birkelund, J.R.; Schroeder, W.U.; Huizenga, J.R. Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Results are presented for the damped reaction ^{144}Sm + ^{84}Kr at laboratory energies of 470, 595 and 270 MeV, corresponding to 1.2, 1.6 and 1.9 times the Coulomb barrier energy, respectively. Correlations between angle, kinetic-energy loss and charge of the projectile-like fragments are discussed. A high probability for orbiting is observed at all bombarding energies, with fragment kinetic energies indicative of large exit-channel deformations. This study shows that energy dissipation (up to $\approx$ 100 MeV) and charge exchange are correlated in a manner which appears to be independent of initial relative ion velocity. The results are compared with a classical dynamical transport model.

5502 **(DOE/ER/10493—13) Atomic masses of fission product nuclei far from stability.** Brenner, D.S. (Clark Univ., Worcester, MA (USA)). 1983. Contract AC02-79ER10493. 22p. (CONF-8310104—4). NTIS, PC A03/MF A01. Order Number DE84003419.

From Specialists meeting on yields and decay data of fission product nuclides; Upton, NY, USA (24 Oct 1983).

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The techniques for measuring fission product masses far from stability are discussed and recent progress in experimental measurements is reviewed. A comparison of new mass values with predictions of 10 mass equations suggests that most theories predict far-from-stability fission product nuclei to be more bound than is found experimentally. A closer look at several isotopic chains is used to identify regions of structural change where mass equations encounter difficulty. 31 references.

5503 **(INIS-mf—8441) Study of transversal nuclear excitations in ^{90}Zr and ^{140}Ce by high-resolution inelastic electron scattering.** Meuer, D. (Technische Hochschule Darmstadt (Germany, F.R.). Fachbereich Physik). 2 Jul 1981. 123p. (In German). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83703260.

Thesis (Ph.D.).

By high-resolution inelastic electron scattering in the nuclei ^{90}Zr and ^{140}Ce magnetic dipole and quadrupole excitations were searched. For this ten ^{90}Zr spectra in the excitation energy range Esub(x) = 8 to 10 MeV at electron energies E_o = 24 to 67 MeV at scattering angles theta = 141° to 165° and six ^{140}Ce spectra in the excitation energy range Esub(x) = 5.5 to 11.5 MeV at electron energies Esub(o) = 30 to 50 MeV at scattering angles theta = 93°, 129°, and 165° were taken up. The analysis of the experimental cross sections was performed by microscopical DWBA calculations using RPA amplitudes which were determined in the framework of a separable residual interaction model. In ^{90}Zr three Jsup(π) = 1^+ states at Esub(x) = 8.233, 9.000, and 9.371 MeV were found. There are however indications to further strongly fragmented M1-strength. The upper limit for the whole observed M1-strength in the studied excitation energy range is estimated to Σ B(M1) up <= 2.5 μ^2sub(N). Furthermore a large number of Jsup(π) = 2^- states were found, the center of mass of which lies at Esub(x) approx.= 9 MeV. The analysis of the ^{140} Ce spectra showed that a hitherto as giant M1-resonance interpreted broad structure at Esub(x) approx.= 8.7 MeV represents an accumulation of Jsup(π) = 2^- states with a whole strength of Σ B(M2) up = (6000 +- 2500) μsub(N)^2 fm^2. An estimation of the level density of the Jsup(π) = 2^- states led to a mean level distance of about 10 keV for ^{90} Zr and about 2 keV for ^{140} Ce.

5504 **(PNL-SA—11747) Survey of delayed neutron emission probabilities.** Reeder, P.L. (Pacific Northwest Lab., Richland, WA (USA)). Oct 1983. Contract AC06-76RL01830. 32p. (CONF-8310104—5). NTIS, PC A03/MF A01. Order Number DE84003348.

From Specialists meeting on yields and decay data of fission product nuclides; Upton, NY, USA (24 Oct 1983).

This paper summarizes the techniques used to measure the delayed neutron emission probability and includes an evaluated list of all experimental values for fission product precursors. Various models and theories for calculating these probabilities are summarized. The application of estimated and experimental delayed neutron emission probabilities to the calculation of delayed neutron yields from fission is illustrated. Some suggestions for new and improved measurements are presented. Emission probabilities for non-fission product precursors are compiled in a separate table. The recently discovered processes of beta-delayed two-neutron and beta-delayed three-neutron emission are reviewed. 87 references.

5505 **Anomalous transitions in ^{144}Nd and ^{146}Nd in '2 keV' (n,γ) measurements.** Raman, S.; Shahal, O. (Oak Ridge National Lab., TN (USA)); McClure, D.A.; Kenny, M.J. (Brookhaven National Lab., Upton, NY (USA)). pp 435-436 of Neutron-capture gamma-ray spectroscopy and related topics 1981. Egidy, T. von; Goennenwein, FJ.; Maier, B. (eds.). Bristol, England; Institute of Physics (1982). (CONF-810920—).

From 4. international symposium on neutron-capture gamma-ray spectroscopy and related topics; Grenoble, France (7 Sep 1981).

In '2-keV' (n,γ) measurements, anomalously strong E1 transitions have been observed to known 2^+ levels in ^{144}Nd and ^{146}Nd.

6518 Nuclear Properties And Reactions, A=150-189

REFER ALSO TO CITATION(S) 5492, 5492, 5497

5506 **(CONF-820149—9) Multiquasiparticle configuration effects deduced from the very high frequency discrete lines spectroscopy of ^{165}Yb.** Schuck, C.; Bendjallah, N.; Diamond, R.M.; Ellis-Akovali, Y.; Lindenberg, K.H.; Newton, J.O.; Shih, S.; Stephens, F.S.; Garret, J.D.; Herskind, B. (Lawrence Berkeley Lab., CA (USA); Niels Bohr Inst., Copenhagen (Denmark)). 1982. Contract W-7405-ENG-26. 14p. NTIS, PC A02/MF A01. Order Number DE84003406.

From 20. international meeting on nuclear physics; Bormio, Italy (25 Jan 1982).

New experimental data are presented for ^{165}Yb in which three already known rotational bands are extended up to very high angular frequencies. We do not observe, below h-bar omega/sub c/ ~ 0.45 MeV in any of these three bands the second discontinuity occuring for h-bar omega/sub c/ ~ 0.42 MeV in N = 90 nuclei. Furthermore, we observe in these three sequences a dealignment of high enough amplitude that it cannot be explained in terms of a single quasi-neutron configuration, and must then be due to a collective effect. A gradual decrease of the neutron pairing with increasing angular frequencies is suggested.

5507 (DOE/ER/03274—4, pp 88-109) **Spectra of energetic neutrons and nuclear γ-rays from μ^--capture in ^{165}Ho.** McIntyre, E.K.; Hallman, T.J.; Kang, K.S.; Kim, C.W.; Lee, Y.K.; Madansky, L.; Mason, G.R. 1983. NTIS, PC A07/MF A01.

In Nuclear moments and nuclear structure. Annual progress report, September 1, 1982-August 31, 1983.

The neutron spectrum resulting from μ^--capture in ^{165}Ho has been measured with a time-of-flight spectrometer. For the first time a 13 MeV peak, and a break in the slope at 40 MeV is reported. The slope from 20 to 40 MeV is 8.88 +- 1 MeV. This represents the first measurement of the neutron spectra by a system capable of resolving neutron energies near the muon mass. Neutron spectra from final nuclear states roughly identified by NaI pulse height are presented. A photon spectrum measured by Ge(Li) detectors exhibits neutron multiplicities up to 5 with an intensity greater than expected.

5508 (DOE/ER/03274—4, pp 110-137) **Neutron spectra coincident with identified final states in π^- capture in ^{165}Ho.** McIntyre, E.K. Jr.; Hallman, T.J.; Kang, K.S.; Lee, Y.K.; Madansky, L.; Mason, G.R. 1983. NTIS, PC A07/MF A01.

In Nuclear moments and nuclear structure. Annual progress report, September 1, 1982-August 31, 1983.

Neutron energy spectra from the exclusive pion capture reaction Ho(π, γxn)Dy are presented. Neutron time-of-flight data was collected in coincidence with nuclear gamma rays which identified the final nuclear state. Most of the ground state band levels up to 12^+ in even-even Dy isotopes were included. These correspond to odd neutron multiplicities from 3 to 11. The spectra show significant changes with neutron multiplicity, exhibiting a sharp cutoff at characteristic energies. Structure in the high energy component of the spectra has been resolved for the first time, and its correlation to the population of high-spin states is observed. This discrete component is strongest in coincidence with the $8^+ \rightarrow 6^+$ transition in ^{160}Dy and ^{158}Dy (neutron multiplicities 5 and 7). The capture reaction preferentially populates the 4^+ and 6^+ states in the ground state bands of ^{160}Dy and ^{162}Dy, corresponding to neutron multiplicities 5 and 3.

5509 **(DOE/ER/03496—78) Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.** Huizenga, J.R.; Schroeder, W.U. (Rochester Univ., NY (USA). Dept. of Chemistry and Physics). Aug 1983. Contract AC02-76ER03496. 337p. (COO—3496-78). NTIS, PC A15/MF A01. Order Number DE83017895.

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Separate abstracts were prepared for papers from the progress report for the period August 1, 1982 to August 31, 1983 for the University of Rochester studies of heavy ion reactions. (KAW)

5510 (DOE/ER/03496—78, pp 5-21) **Fusion cross sections for the ^{165}Ho + ^{56}Fe reaction.** Birkelund, J.R.; Hoover, A.D.; Huizenga, J.R.; Schroeder, W.U.; Wilcke, W.W. (Rochester Univ., NY). Aug 1983. NTIS, PC A15/MF A01. (COO—3495-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Fusion cross sections are reported for the ^{165}Ho + ^{56}Fe reaction at bombarding energies of 351, 421, 462 and 510 MeV. These results, along with those for the ^{165}Ho + ^{40}Ar and ^{165}Ho + ^{84}Kr reactions, are in agreement with a recent model of Swiatecki. For (Z^2/A)/sub eff/ < 30, an extra push energy is found to be required for fusion when (E - V/sub B/)/μ > (2.0 +- 0.3) MeV per nucleon.

5511 (DOE/ER/03496—78, pp 21-61) **Angular distributions of fragments from fission induced by 220-MeV ^{20}Ne on targets of ^{165}Ho, ^{197}Au and ^{209}Bi.** Rossner, H. (Hahn-Meitner-Ins. fuer Kernforschung Berlin, Germany); Hilscher, D.; Holub, E.; Ingold, G.; Jahnke, U.; Orf, H.; Huizenga, J.R.; Birkelund, J.R.; Schroeder, W.U.; Wilcke, W.W. Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Fragment angular distributions are reported for 220-MeV ^{20}Ne induced fission of ^{165}Ho, ^{197}Au and ^{209}Bi. The experimental anisotropies are underestimated and overestimated, respectively, by calculations using the moments of inertia derived from the rotating and non-rotating (I = O) liquid-drop models. Account is taken in the theoretical calculations of both prefission particle emission and incomplete fusion. It is possible to obtain satisfactory fits to the experimental angular distributions with spin dependent values of I/sub sph/I/sub eff/ if the rotating liquid-drop model condition that I/sub sph/I/sub eff/ goes to zero at I/sub RLDM/(B/sub f/ = O) is relaxed. For heavy-ion induced fusion-fission reactions, as I/sub f/ exceeds I/sub RLDM/ and the unconditional saddle-point energy has gone to zero, the saddle-point configuration plays less and less of a role in establishing K_0^2.

5512 (DOE/ER/03496—78, pp 167-181) **New mechanism of α-particle production in heavy-ion induced fission.** Wilcke, W.W.; Kosky, J.P.; Birkelund, J.R.; Butler, M.A.; Dougan, A.D.; Huizenga, J.R.; Schroeder, W.U.; Wollersheim, H.J. (Rochester Univ., NY). Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Detailed studies have been made of the multiplicity, energy and angular distributions of α particles emitted in coincidence with fission fragments from the ^{165}Ho + ^{56}Fe (E/sub Lab/ = 465 MeV) reaction. Approximately 90% of the α particles are evaporated from the two fully accelerated fission fragments. The remaining α particles have a strongly enhanced emission probability in the direction perpendicular to the scission axis, suggesting the contact or neck region between the fragments as the source of these particles.

5513 (DOE/ER/03496—78, pp 181-193) **Alpha-particle emission in the strongly damped reaction of ^{165}Ho + ^{56}Fe at 8.3 MeV/nucleon.** Kosky, J.P. (Rochester Univ., NY); Wilcke, W.W.; Birkelund, J.R.; Butler, M.A.; Dougan, A.D.; Huizenga, J.R.; Schroeder, W.U.; Wollersheim, H.J.; Hilscher, D. Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Alpha-particle emission in coincidence with damped reaction fragments is studied for the ^{165}Ho + ^{56}Fe (E/sub lab/ = 465 MeV) reaction. Statistical emission from the two fully accelerated strongly damped reaction fragments accounts for the dominant sources of the α-particles. The α-particle multiplicity M/sub α/ depends strongly on the fragment excitation energy and atomic number, with an average multiplicity <M/sub α/> = 0.2 for Fe-like fragments from damped reaction events with -Q > 100 MeV. Temperatures derived from neutron and α-particle spectra are in good agreement.

5514 (DOE/ER/03496—78, pp 193-207) **Limitation of linear momentum transfer in heavy-ion reactions.** Huizenga, J.R. (Rochester Univ., NY); Birkelund, J.R.; Tubbs, L.E.; Hilscher, D.; Jahnke, U.; Rossner, H.; Gebauer, B.; Lettau, H. Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

Angular correlations of fragments from 292-MeV ^{20}Ne induced fission of ^{165}Ho, ^{181}Ta, ^{197}Au, ^{209}Bi and ^{233}U have been measured. The correlations are interpreted in terms of a full linear momentum transfer component and several components with less than full momentum transfer. The maximum angular momentum, 2/sub FLMT/, associated with the full linear momentum transfer component from these and other previous angular correlation measurements, as well as from velocity measurements of evaporation residues, corresponds to rolling heavy ion collisions.

5515 **Test of Axel-Brink predictions in the ^{167}Er (n,γ) ^{168}Er reaction.** Kahane, S.; Slaughter, G.G.; Raman, S. (Oak Ridge National Lab., TN (USA)). pp 433-434 of Neutron-capture gamma-ray spectroscopy and related topics 1981. Egidy, T. von; Goennenwein, F.; Maier, B. (eds.). Bristol, England; Institute of Physics (1982). (CONF-810920—).

From 4. international symposium on neutron-capture gamma-ray spectroscopy and related topics; Grenoble, France (7 Sep 1981).

The average radiation widths of primary γ rays in the reaction ^{167}Er(n,γ)^{168}Er are in reasonable agreement with the Axel-Brink predictions based on a giant dipole resonance model.

6519 Nuclear Properties And Reactions, A=190-219

REFER ALSO TO CITATION(S) 5497, 5509, 5511, 5514

5516 **(CONF-8307100—2) Giant resonances - why protons.** Bertrand, F.E. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 52p. NTIS, PC A04/MF A01. Order Number DE84003296.

From TRIUMF workshop on studying nuclei with medium energy protons; Alberta, Canada (11 Jul 1983).

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Protons excite giant resonances, indeed the systematic establishment of the existence of the first non-dipole giant resonance, the giant quadrupole resonance (GQR) came from the use of inelastic proton scatering. The question addressed, however, is how does the proton stack up for such studies when compared to the use of other hadronic probes? What can we uniquely learn about giant multipole resonances using proton scattering. Specifically, results from (p, p'), and (α, α') and (^{16}o, ^{16}O') reactions are compared as regards excitation of giant multipole resonances, and some of the advantages and disadvantages to the use of each probe are detailed. It is hoped to leave the impression that it is in the determination of resonance multipolarity by comparison of measured and calculated angular distributions that the proton is a winner. It is shown what we are learning about high-L (L > 3) giant resonances using the (p, p') angular distribution. This discussion will generally be limited to isoscalar electric (i.e., T = 0, S = 0) giant resonances.

5517 **(WIS-PH—81/46) Electric quadrupole moments of high spin isomers in ^{209}Po and ^{210}Po.** Dafni, E.; Rafailovich, M.H.; Marshall, T.; Schatz, G.; Sprouse, G.D. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Sep 1981. 20p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703843.

High spin ^{209,210}Po isomers were recoil implanted into tetragonal tin and the electric quadrupole coupling constants have been measured with the TDPAC technique. Using a calculated value for the quadrupole moment of $Q[^{210}Po(8^+)] = 57$ fm^2 as standard for the electric field gradient calibration, the following other values are derived: $Q[^{209}Po(17/2^-)] = 39(8)$fm^2, $Q[^{210}Po(11^-)] = 82(19)$fm^2 and $Q[^{210}Po(13^-)] = 62(11)$fm^2. These values are in agreement with the known structure of the isomers. The existence of more than one isomer in each isotope has required a data analysis procedure which takes into account feeding through all levels perturbed by the quadrupole interaction.

5518 **Heavy ion reactions in the transition region.** Hendrie, D.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). pp 54-62 of Proceedings of international symposium on nuclear physics at cyclotron energies [held at] Calcutta, September 14-16, 1977. Calcutta, India; Bhabha Atomic Research Centre (1979). (CONF-770975—).

From International symposium on nuclear physics at cyclotron energies; Calcutta, India (14 Sep 1977).

Evidence is given for a serious and systematic failure of the DWBA to predict the cross sections for single nucleon transfers induced by heavy ions above about 10 MeV/nucleon beam energies. This is perhaps related to a coherent coupling to an increasing cross section to the quasi-elastic continuum, which also shows an anomalous energy dependence at about the same energy.

6520 Nuclear Properties And Reactions, A=220 And Above

REFER ALSO TO CITATION(S) 5497, 5509, 5514

5519 **(ANL/NDM—83) Fission cross sections of some thorium, uranium, neptunium and plutonium isotopes relative to ^{235}U.** Meadows, J.W. (Argonne National Lab., IL (USA)). Oct 1983. Contract W-31-109-ENG-38. 74p. NTIS, PC A04/MF A01. Order Number DE84003214.

Portions are illegible in microfiche products.

Earlier results from the measurements, at this Laboratory, of the fission cross sections of ^{230}Th, ^{232}Th, ^{233}U, ^{234}U, ^{236}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, and ^{242}Pu relative to ^{235}U are reviewed with revisions to include changes in data processing procedures, alpha half lives and thermal fission cross sections. Some new data have also been included. The current experimental methods and procedures and the sample assay methods are described in detail and the sources of error are presented in a systematic manner. 38 references.

5520 **Use of integral cross-section measurements in evaluating the ^{252}Cf spontaneous fission neutron spectrum.** LaBauve, R.J.; Madland, D.G. (Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545). *Transactions of the American Nuclear Society;* **44**: 538-540(Jun 1983). (CONF-830609—).

From ANS annual meeting; Detroit, MI, USA (12 Jun 1983).

5521 **Thermal-neutron absorption cross section of sulfur and the ^{252}Cf ν problem.** Jurney, E.T. (Los Alamos National Lab., NM (USA)); Raman, S.; Spencer, R.R. (Oak Ridge National Lab., TN (USA)). pp 381-382 of Neutron-capture gamma-ray spectroscopy and related topics 1981. Egidy, T. von; Goennenwein, F.; Maier, B. (eds.). Bristol, England; Institute of Physics (1982). (CONF-810920—).

From 4. international symposium on neutron-capture gamma-ray spectroscopy and related topics; Grenoble, France (7 Sep 1981).

The 2200 m/s neutron absorption cross section for natural sulfur was measured to be 513 +- 15 mb. Any discrepancy between $MnSO_4$-bath and liquid scintillator measurements of ^{252}Cf(ν) cannot be attributed to a discrepancy in this cross section value.

5522 **Parity assignment of the pronounced structure in radiative capture of neutrons by ^{235}U below 100 keV.** Moore, M.S. (Los Alamos National Lab., NM (USA)); Corvi, F. (Commission of the European Communities, Geel (Belgium). Central Bureau for Nuclear Measurements); Mewissen, L.; Poortmans, F. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). pp 415-416 of Neutron-capture gamma-ray spectroscopy and related topics 1981. Egidy, T. von; Goennenwein, F.; Maier, B. (eds.). Bristol, England; Institute of Physics (1982). (CONF-810920—).

From 4. international symposium on neutron-capture gamma-ray spectroscopy and related topics; Grenoble, France (7 Sep 1981).

Results are presented of an experimental determination of the parity of an intermediate structure in the radiative capture cross section of ^{238}U, using a neutron-capture gamma-ray spectroscopic method.

6530 Nuclear Theory

REFER ALSO TO CITATION(S) 5499, 5509, 5541, 5542

5523 (DOE/ER/03496—78, pp 207-309) **Fusion reactions between heavy nuclei.** Birkelund, J.R.; Huizenga, J.R. (Rochester Univ., NY). Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

The classification of reactions between heavy nuclei, the definition of fusion and the measurement of fusion cross sections are discussed. Several models for the calculation of fusion excitation functions are considered. Models based on the liquid drop method appear to be most satisfactory and are discussed in some detail. (KAW)

5524 (DOE/ER/03496—78, pp 310-330) **General purpose code for Monte Carlo simulations.** Wilcke, W.W. (Rochester Univ., NY). Aug 1983. NTIS, PC A15/MF A01. (COO—3496-78).

In Studies of heavy-ion reactions and transuranic nuclei. Progress report, August 1, 1982-August 31, 1983.

A general-purpose computer called MONTHY has been written to perform Monte Carlo simulations of physical systems. To achieve a high degree of flexibility the code is organized like a general purpose computer, operating on a vector describing the time dependent state of the system under simulation. The instruction set of the computer is defined by the user and is therefore adaptable to the particular problem studied. The organization of MONTHY allows iterative and conditional execution of operations.

5525 (DOE/ER/03992—528, pp 15-27) **Construction of rigged Hilbert spaces to describe resonances and virtual states.** Gadella, M. (Facultad de Ciencias de Santander, Spain). Aug 1983. NTIS, PC A03/MF A01.

In Decay phenomena and rigged Hilbert spaces: two lectures.

In the present communication we present a mathematical formalism for the description of resonances and virtual states. We start by constructing rigged Hilbert spaces of Hardy class functions restricted to the positive half of the real line. Then resonances and virtual states can be written as generalized eigenvectors of the total Hamiltonian. We also define time evolution on functionals. We see that the time evolution group U(t) splits into two semigroups, one for $t > 0$ and the other for $t < 0$, hence showing the irreversibility of the decaying process.

5526 **(LA-UR—83-2973) Boson-mediated interactions between static sources.** Bolsterli, M. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 11p. (CONF-8306136—1). NTIS, PC A02/MF A01. Order Number DE84001712.

From International symposium on quarks and nuclear structure; Bad Honnef, F.R. Germany (13 Jun 1983).

The techniques are now available for doing accurate computations of static potentials arising from the exchange of virtual

mesons. Such computations must take account of the fact that different approximation methods must be used in the regions where R is large and where R is small. In the asymptotic region, the distorted-field approximation provides an appropriate starting-point, but it must be improved before trustworthy results are obtained for all but the largest values of R. In the region of small R, accurate strong-coupling methods are based on the use of states with coherent meson pairs. For small R, it is also important to take account of the possibility of meson emission or near-emission. Current work is aimed at applying the techniques described to the case of static sources interacting via pion field. In particular, it will be interesting to see how sensitive the potential is to the value of the cutoff Λ. Other areas of application are the study of the effects of nonlinearity and models of quark-quark and quark-antiquark potentials. 17 references.

5527 **Polarizability of nuclear wave functions in heavy ion reactions.** Charlton, L.A.; Delic, G.; Glandennino-, N.K.; Pruess, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). pp 142-147 of Proceedings of international symposium on nuclear physics at cyclotron energies [held at] Calcutta, September 14-16, 1977. Calcutta, India; Bhabha Atomic Research Centre (1979). (CONF-770975—).

From International symposium on nuclear physics at cyclotron energies; Calcutta, India (14 Sep 1977).

Evidence is presented for the polarizability of nuclear wave functions in heavy ion transfer reactions. The polarization of the wave function of the transferred nucleon is largest for weakly bound nucleons, depends on the bombarding energy, being largest for low energy (slow) collisions, and produces a shift toward forward angle. Results of an adiabatic estimate employing two-center shell model wave functions in a DWBA amplitude are presented. A dynamical theory is sketched which involves a superposition of many transitions through excited bound and continuum states of the weakly bound nucleon. It is shown how the adiabatic amplitude emerges as the lowest approximation.

6540 Radiation And Shielding Physics

REFER ALSO TO CITATION(S) 5033, 5242, 5494

5528 **(SAND—83-1398C) Resonance between channeled particle wavelengths and periodicity of strained-layer superlattices.** Chu, W.K.; Picraux, S.T.; Biefield, R.M.; Osbourn, G.C.; Ellison, J.A. (North Carolina Univ., Chapel Hill (USA). Dept. of Physics and Astronomy; Sandia National Labs., Albuquerque, NM (USA); New Mexico Univ., Albuquerque (USA). Dept. of Mathematics). 1983. Contract AC04-76DP00789. 9p. (CONF-831174—18). NTIS, PC A02/MF A01. Order Number DE84002173.

From Materials Research Society annual meeting; Boston, MA, USA (14 Nov 1983).

Portions are illegible in microfiche products.

Recent studies of the resonance effect between the wavelength of planar channeled ions and the periodicity of strained-layer superlattices are summarized for MeV ^{4}He ions backscattering from GaAs/sub x/P/sub 1-x//GaP superlattices. When the incident beam energy is adjusted so the half-wavelength matches the thickness of the layers, a catastropic dechanneling effect is observed. A simple phase rotation analysis has been developed to calculate the dechanneling in each layer and good agreement is obtained with the observed dechanneling per interface. This resonance effect is used to measure the amount of strain in the GaAs/sub x/P/sub 1-x//GaP strained-layer superlattice.

5529 **(UCRL—89454) Planar channeling radiation from relativistic positrons and electrons in LiF.** Berman, B.L.; Datz, S.; Fearick, R.W.; Swent, R.L.; Pantell, R.H.; Park, H.; Kephart, J.O.; Klein, R.K. (Lawrence Livermore National Lab., CA (USA); Oak Ridge National Lab., TN (USA); Stanford Univ., CA (USA). Dept. of Electrical Engineering). Jul 1983. Contract W-7405-ENG-48. 15p. (CONF-830780—3). NTIS, PC A02/MF A01. Order Number DE84002800.

From International conference on atomic collisions in solids; Bad Iburg, F.R. Germany (18 Jul 1983).

Channeling radiation has been measured for planar-channeled 54- and 83-MeV positrons and 17-, 31-, and 54-MeV electrons in the ionic crystal LiF. The results are shown to be in reasonable, but not perfect, agreement with the results of many-beam calculations based upon a model of the crystal as an array of isolated Li^+ and F^- ions.

5530 **Application of finite element method in the solution of steady state diffusion equation.** Ono, S. Sao Paulo, Brazil; Instituto de pesquisas Energeticas e Nucleares (1982). 112p. (In Portuguese). IPEN, Sao Paulo, Brazil.

Thesis (Ph.D.).

The solution of the steady state neutron diffusion equation is obtained by using the finite element method. Specifically the variational approach is used for one-dimensional problems and the weighted residual method (Galerkin) for one- and two-dimensional problems. The spatial domain is divided into rectangular elements and the neutron flux is approximated by linear (one-dimensional case), and bilinear (two-dimensional case) functions. Numerical results are obtained with a FORTRAN IV computer program and compared with those obtained by the finite difference CITATION code. The results show that linear or bilinear functions, do not satisfactorily describe the differential parameters in highly heterogeneous reactor cases, but provide good results for integral parameters such as multiplication factor.

5531 **One-dimensional gamma-ray and photoneutron shielding calculations for the ELMO Bumpy Torus proof of principle device.** Lillie, R.A.; Baker, V.C.; Bishop, B.L.; Gabriel, T.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee). *Nuclear Technology/Fusion;* **1**: No. 4, 542-551(Oct 1981).

One-dimensional radiation transport calculations have been performed to obtain estimates of the nuclear heat loads and biological dose rates due to bremsstrahlung gamma rays and photoneutrons in the ELMO Bumpy Torus proof of principle device. The bremsstrahlung gamma rays arise because of electron impingement on the magnetic coil assemblies, and these gamma rays in turn produce photoneutrons through interactions in the high-Z shielding materials. For a 1-MW electron power loss, ^{238}U and tungsten coil shield thicknesses of 22.5 and 27.3 mm, respectively, were found sufficient to limit the nuclear heat load on a single superconducting coil to 10 W. The estimated lead and concrete primary shield thicknesses required to reduce the biological dose rate due to bremsstrahlung gamma rays to 2.5 mrem/h were calculated to be 0.318 and 1.92 m, respectively. Because of photoneutron production, however, lead by itself was not found to be an acceptable biological shield.

6550 Medical Physics

5532 **(DOE/EV/04326—5) In vivo measurements of bone-seeking radionuclides. Annual report, December 1, 1982-November 30, 1983.** Cohen, N. (New York Univ., NY (USA). Inst. of Environmental Medicine). 1983. Contract AC02-77EV04326. 97p. (COO—4326-5). NTIS, PC A05/MF A01. Order Number DE84003034.

This report summarizes results obtained in seven areas. Five subjects with well defined Am-241 body burdens have been measured using NaI-CsI(T1) detectors surrounding the head or positioned over the anterior knee surfaces. The observed ratio of net count-rate at the skull to net count-rate at the anterior knee surfaces was found to vary with values ranging from 1.16 to 2.45. Previously developed calibration values for men have been determined to be inadequate for application to female workers due to the variability in chest wall thickness and different photon attenuation characteristics of breast tissue in women. The relative count-rates for each individual among the counting geometries reflected the attenuation of the Nb-92m x-rays in the overlying tissue. The measurement performed with a single phoswich detector positioned centrally over the sternum surprisingly gave the highest count-rate for two out of the four subjects. It is expected that the net counts/x-ray emitted for each individual, when plotted as a function of overlying absorber thickness, will produce a series of single exponential curves which can be used to predict the absolute calibration value

for Nb-92m in the lungs. Additional studies describing the time-related fate and distribution in the body of radon and radon daughters present as a result of drinking this well water are currently in progress. There appears to be a possibility of obtaining a significantly increased and variable whole body count-rate as related to a function of the quantity of water consumed and the time of in vivo measurement. Subjects who were treated therapeutically with radon seeds 25 to 34 years ago were observed in our whole body counting facility using NaI-CsI(Tl) detectors. The radiation dose due to the characteristic Pu x-ray, the bremsstrahlung continuum and any beta radiation penetrating the gold sheath, is being determined.

6560 Solid State Physics

REFER ALSO TO CITATION(S) 4942, 4990, 4991, 5466

5533 **(AERE-TP—973) Theory of muon behaviour.** Browne, A.M. (UKAEA Atomic Energy Research Establishment, Harwell. Theoretical Physics Div.). Dec 1982. 206p. HMSO, London, price Pound 10.00.

The interactions of light interstitial particles with impurities in a solid host are considered through (a) their effects on the diffusive and self-trapping behaviour of positive muons (μ^+) (mainly in metals) and (b) the phonon spectra of CaF_2 doped with hydrogen and rare earth ions; the complementary roles of the μ^+ and the hydrogen ion as probes are also highlighted. It is postulated that preferential localization of a thermalized (or nearly so) μ^+ at or near defect centres is more likely than the random self-trapping in conventional theories. This idea is supported by a calculation of the relative probabilities of μ^+ trapping due to thermal fluctuations of the host vibrations on the one hand and static strain fields associated with defects on the other. The hydrogen ion as a light interstitial in CaF_2 doped with rare earth ions is used as a source of data to calculate a complete set of hydrogen-rare earth interaction potentials. Both analytic and numerical methods are used. The latter are based on the electron gas approximation. The stabilities and the characteristic phonon spectra of the rare earth hydrides are calculated using these potentials to demonstrate their transferability from one system to another.

5534 **(SAND—83-0429C) Theory of dynamical ferroelectricity.** Chen, P.J. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 11p. (CONF-8306143—1). NTIS, PC A02/MF A01. Order Number DE84002609.

From Wave phenomena conference; Toronto, Canada (1 Jun 1983).

This paper gives a dynamical theory of ferroelectricity. The theory takes into account the transient effects due to domain switching and dipole dynamics. A specific representation is derived for departures from the virgin state which is taken to be a natural reference state, and allows for changes in material symmetry due to domain switching and dipole dynamics.

5535 **Glide and climb stresses on secondary slip systems in F.C.C. crystals due to isolated primary edge and screw dislocations.** Jesser, W.A.; Kuhlmann-Wilsdorf, D. (Univ. of Virginia, Charlottesville). *Materials Science and Engineering;* **51**: 31-37(1981).

The climb and glide stresses resulting from an isolated 1/2[101](111) edge dislocation as well as from an isolated 1/2[101] screw dislocation were calculated for all possible <110>{111} and <110>{100} slip systems. Knowledge of these stresses is needed in studies of glide on non-primary slip systems as affected by agglomerations of primary dislocations, especially pile-ups, or the loop patches and dipolar walls observed in fatigued specimens. The same data are believed also to be highly applicable to fracture studies in that the stresses about a mode I crack resemble those of a set of edge dislocations along the crack edge with their Burgers vectors normal to the plane of the crack. Similarly, a mode II crack may be simulated by an edge dislocation whose Burgers vector lies in the plane of the crack normal to the crack edge, and a mode III crack may be simulated by a screw dislocation.

5536 **Crack tip shielding--an elastic theory of dislocations and dislocation arrays near a sharp crack.** Majumdar, B.S.; Burns, S.J. (Univ. of Rochester, NY). *Acta Metallurgica;* **29**: 579-588(1981). Contract AS02-76ER02422.

An elastic solution has been found for a screw dislocation near a crack in the absence of any external stresses. The dislocation produces a stress intensity factor on the crack even without external stresses. The stress intensity factor at the crack tip plus the dislocation's contribution to the stress intensity factor add to the stress intensity factor due to the applied stresses. Also the interaction between the crack and dislocations, and between dislocations in the presence of the crack can be solved by simply considering the associated stress intensity factors at the crack tip. Several additional solutions derived are two dislocations at the crack tip, a dislocation off the crack plane, a circle of dislocations around the crack tip and a finite length crack with external stresses.

5537 **Crack tip shielding--an elastic theory of dislocations and dislocation arrays near a sharp crack.** Majumdar, B.S.; Burns, S.J. (Univ. of Rochester, NY). *Acta Metallurgica;* **29**: 579-588(1981). Contract AS02-76ER02422.

An elastic solution has been found for a screw dislocation near a crack in the absence of any external stresses. The dislocation produces a stress intensity factor on the crack even without external stresses. The stress intensity factor at the crack tip plus the dislocation's contribution to the stress intensity factor add to the stress intensity factor due to the applied stresses. Also the interaction between the crack and dislocations, and between dislocations in the presence of the crack can be solved by simply considering the associated stress intensity factors at the crack tip. Several additional solutions derived are two dislocations at the crack tip, a dislocation off the crack plane, a circle of dislocations around the crack tip and a finite length crack with external stresses.

6561 Superconductivity

REFER ALSO TO CITATION(S) 4972, 5037

5538 **(CONF-8308132—2) Theory of elementary excitations in intermediate valence materials.** Fedro, A.J.; Sinha, S.K. (Argonne National Lab., IL (USA)). Oct 1983. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01. Order Number DE84003705.

From NATO/CAP institute on moment formation in solids; Vancouver Island, Canada (21 Aug 1983).

We review the formalism for calculating the properties of systems represented by an Anderson lattice Hamiltonian. First, a mean-field theory for the one electron Green's function is presented and then extended to include spin and charge fluctuations which lead to a many-body resonance near the Fermi level. The dynamical spin susceptibility and neutron scattering cross section are also evaluated. Finally, we present a calculation which indicates the possibility of a Cooper-pairing mechanism induced by electron correlations.

5539 **Further tests of the Argonne 3.3-MJ pulsed superconducting coil and its nonmetallic cryostat.** Kim, S.; Krieger, C.; McGhee, D. (Argonne National Lab., Argonne, IL 60439). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 346-349(May 1983).

A split-pair superconducting coil of the Pulsed Cable Test Facility (PCTF) at Argonne National Laboratory (ANL) has been successfully tested both in DC and pulsing modes. At a peak operating current of 11 kA, the peak magnetic field and stored energy of the coil are 6.5 T and 3.3 MJ, respectively. In the pulsing test, the coil was charged to 10.55 kA in 1.0 s and discharged to zero in 1.6 s. The ac losses of the coil in this mode were 7.5 kJ/pulse. The coil is composed of two solenoids each with 22 layers and 9.14 turns per layer. The cable for the coil consists of 24, 19-strand NbTi subcables. The nonmetallic cryostat of the PCTF consists of two fiberglass reinforced polyester resin vessels. Developmental high current conductors can be tested under the PCTF pulsing

magnetic fields in a form of pancake coils or as a short sample for the studies of pulsing effects.

5540 **Empirical scaling formulas for critical current field for commercial NbTi.** Lubell, M. (Fusion Energy Div., Oak Ridge Nat'l Lab., Oak Ridge, TN 37830). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* **19**: No. 3, 754-757(May 1983). Contract W-7405-ENG-26.

Short sample 4.2 K experimental facilities are plentiful, but equipment for measurements of current as functions of temperature and field is scarce. An analysis has been made of published data comprising at least six manufacturers and spanning a range of critical current density at 4.2 K, 8 T of 50 to 108 kA/cm², and linear equations have been found to fit the data over a wide range of field B and temperature T. For a constant temperature of 4.2 K, the following expression holds for B in the range of 3 to 10 T: j /SUB c/ (B, T = 4.2 K) = j /SUB o/ (1 - 0.096B), where (B /SUB c2/ (4.2 K))$^{-1}$ = 0.096 with a standard deviation of 3% for ten samples. The constant j /SUB o/ can be determined for any sample from a single point measurement at a convenient field. For a constant field of 8 T, the following expression holds for T in the range of 2 to 5.5 K: j /SUB c/ (B = 8 T, T) = j /SUB o/ (1 - 0.177T), where (T / SUB c/ (8 T))$^{-1}$ = 0.177 with a standard deviation of less than 1%. Linear equations have also been obtained for higher fields and lower temperatures. The critical field vs temperature is B /SUB c2/ (T) = B /SUB c2/ (0) (1 - (T/T /SUB c/ (0)) /SUP n/), where B /SUB c2/ (0) = 14.5 T, T /SUB c/ (0) = 9.2 K, and n = 1.7 (not 2, which is used in theoretical derivations). For more accurate critical temperature calculations above 10 T, this equation can be used with the modification B /SUB c2/ (0) = 14.8 T. No one simple power law for the upper critical field holds over the whole temperature range.

6570 Theoretical Physics

REFER ALSO TO CITATION(S) 5525

5541 **(DOE/ER/03992—528) Decay phenomena and rigged Hilbert spaces: two lectures.** Bohm, A.; Gadella, M. (Texas Univ., Austin (USA). Center for Particle Theory). Aug 1983. Contract AS05-76ER03992. 28p. NTIS, PC A03/MF A01. Order Number DE84002847.

Separate abstracts were prepared for the two papers included. (WHK)

5542 (DOE/ER/03992—528, pp 1-14) **Decaying states and the rigged Hilbert space formulation of quantum mechanics.** Bohm, A. (Univ. of Texas, Austin). Aug 1983. NTIS, PC A03/MF A01.

In Decay phenomena and rigged Hilbert spaces: two lectures.

Gamow vectors are defined as generalized eigenvectors (functionals) of the self-adjoint Hamiltonian with complex eigenvalue and exponential time development which are connected with a pair of second sheet S-matrix poles. The rigged Hilbert space formulation of quantum mechanics (called Gamow vectors) is described. 9 references. (WHK)

5543 **(INIS-mf—8590) Nonlinear von Neumann equations for quantum dissipative systems.** Messer, J.; Baumgartner, B. (Vienna Univ. (Austria)). [nd]. 9p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703838.

For pure states nonlinear Schroedinger equations, the so-called Schroedinger-Langevin equations are well-known to model quantum dissipative systems of the Langevin type. For mixtures it is shown that these wave equations do not extend to master equations, but to corresponding nonlinear von Neumann equations. Solutions for the damped harmonic oscillator are discussed.

5544 (INIS-SU—168, pp 278-282) **Field theory methods for integration of two-dimensional exactly solvable dynamical models (classical and quantum region).** Leznov, A.N.; Saveliev, N.V. 1982. NTIS (US Sales Only), PC A17/MF A01. (CONF-820778—Vol.1).

From 5. international seminar on high energy physics and field theory; Protvino, USSR (12 Jul 1982).

The report is devoted to the application of standard perturbation methods of quantum mechanics and field theory for the construction of finite explicit expressions for the solutions of exactly integrable dynamical systems in one- and two-dimensional spaces. At the quantum level dynamical systems can be considered in various representations with Schroedinger and Heisenberg ones being the most universal. For 1D-exactly integrable systems the solutions can be obtained in group terms in both representations. The solutions of the corresponding classical systems are obtained from the expressions for the quantum case when Planck constant goes to zero. A modification is briefly formulated of the construction of a general system in quantum region containing Toda lattice as a particular case.

5545 **(UWThPh—83-02) Are x and p incompatible observables.** Reiter, H.; Thirring, W. (Vienna Univ. (Austria)). 1983. 3p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703839.

Common eigenfunctions of nontrivial projectors of x and p are constructed.

5546 **(UWThPh—83-03) Rigorous approach to relativistic corrections of bound state energies for spin-1/2 particles.** Gesztesy, F.; Thaller, B.; Grosse, H. (Vienna Univ. (Austria)). 1983. 23p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83703840.

Under fairly general conditions on the interactions we prove holomorphy of the Dirac resolvent around its nonrelativistic limit. As a consequences, perturbation theory in terms of resolvents (instead of Hamiltonians) yields holomorphy of Dirac eigenvalues and eigenfunctions with respect to c^{-1} and a new method of calculating relativistic corrections to bound state energies. Due to a formulation in an abstract setting our method is applicable in many different concrete situation. In particular our approach covers the case of the relavistic hydrogen atom in external electromagnetic fields.

5547 **Theory and applications of the classification of second order symmetric tensors in Einstein's general theory of relativity.** Crade, R.F. Aberdeen, Scotland; Aberdeen University (1980). 108p. British Library, Boston Spa, Wetherby, West Yorks. No. D36847/81.

Thesis (Ph.D.).

The classification of second order symmetric tensors in general relativity theory is examined. Having defined the tensors to be classified and considered their role in Einstein's theory, the theory of bivectors is introduced. Known methods of classifying Weyl and Ricci tensors are discussed and spaces admitting symmetries and in particular the restrictions imposed on the Ricci tensor by locally isotropic space-times are considered. Finally the classifications of the Ricci tensor due to Ludwig and Scanlon and Penrose are investigated.

5548 **Aspects of metric-torsion theories of gravitation.** Mukku, C. London, England; Imperial College of Science and Technology (1980). 164p. British Library, Boston Spa, Wetherby, West Yorks. No. D36923/81.

Thesis (Ph.D.).

The principles of gauge theories and metric-torsion theories of gravitation and the role of gauge fields in gravitational theories are considered in part 1. Part 2 discusses variational principles and methods of constructing Lagrangians, and their applications to General Relativity.

6580 Mathematical Physics

REFER ALSO TO CITATION(S) 5659

5549 **(SAND—83-2079) Error estimators for stiff differential equations.** Shampine, L.F.; Baca, L.S. (Sandia National Labs., Albuquerque, NM (USA)). Oct 1983. Contract AC04-76DP00789. 23p. NTIS, PC A02/MF A01. Order Number DE84003331.

When solving ordinary differential equations numerically, the local error is estimated at each step. In the classical situation of small step sizes, it is clear what is required of the error estimators. Stiff problems are solved with large step sizes. The quality of error estimators is studied in this situation, and it is shown how to modify unsatisfactory estimators so as to improve them greatly. Several formulas from the literature are treated as examples.

70 FUSION ENERGY

7001 Plasma Research

REFER ALSO TO CITATION(S) 5601

5550 **(CONF-831105—3) Electron transport in EBT in the low collision frequency limit.** Hastings, D.E. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 91p. NTIS, PC A05/MF A01. Order Number DE84003274.

From Meeting of the Plasma Physics Division of the American Physical Society; Los Angeles, CA, USA (7 Nov 1983).

A variational principle formulation is used to calculate the electron neoclassical transport coefficients in a bumpy torus for the low collisionality regime. The electron radial drift is calculated as a function of the plasma position and the poloidal electric field which is determined self-consistently. A bounce-averaged differential collision operator is used and the results are compared to previous treatments using a BGK operator.

5551 **(CONF-831171—15) Characterization of the TEXTOR plasma edge using deposition probe techniques.** Zuhr, R.A. (Oak Ridge National Lab., TN (USA)). Oct 1983. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE84003308.

From American Vacuum Society meeting; Boston, MA, USA (1 Nov 1983).

Carbon and single crystal silicon passive deposition probes were used to measure the characteristics of the plasma edge region of the TEXTOR tokamak. Analysis of the probes was done by Rutherford backscattering for impurities and nuclear reaction analysis and elastic recoil detection for hydrogen isotopes. Plasma fluxes and energies in the edge were measured using probe techniques. The principal impurities in the plasma edge were determined and their behavior as a function of time and position was measured. Measurements were also made of in situ erosion rates. The results are compared with independent measurements of other plasma parameters to study possible impurity introduction mechanisms. This work represents the first deposition probe measurements made in the plasma edge of TEXTOR.

5552 **(LA—9613-MS) Precisely aligned internal magnetic probes for the reversed-field pinch experiment, ZT-40.** Burkhardt, L.C. (Los Alamos National Lab., NM (USA)). Oct 1983. Contract W-7405-ENG-36. 15p. NTIS, PC A02/MF A01. Order Number DE84003704.

A 10-station, 20-coil internal magnetic sensing probe for diagnosing the ZT-40 plasma is described. The coils are precisely aligned for coplanarity and orthogonality to within a fraction of a degree, have a sensitivity of $\sim$ 2.5 cm^{2}t, and are flat to above 2.5 MHz.

5553 **(LBL—16723) Canonical derivation of the Vlasov-Coulomb noncanonical Poisson structure.** Kaufman, A.N.; Dewar, R.L. (Lawrence Berkeley Lab., CA (USA)). Sep 1983. Contract AC03-76SF00098. 8p. NTIS, PC A02/MF A01. Order Number DE84002909.

Starting from a Lagrangian formulation of the Vlasov-Coulomb system, canonical methods are used to define a Poisson structure for this system. Successive changes of representation then lead systematically to the noncanonical Lie-Poisson structure for functionals of the Vlasov distribution.

5554 **(N—8326903) SAFE II: Large systems space plasma evaluation experiment.** Carruth, M.R., Jr.; Young, L.E.; Purvis, C.K.; Stevens, N.J. (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center; National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). May 1983. 16p. NTIS, PC A20/MF A01.

In Large Space Antenna Systems Technol., Pt. 2 p 991-1006 (See N83-26879 16-15).

A shuttle flight experiment, the purpose of which is to obtain space data on the interaction of a high voltage solar array with the ambient space plasma is addressed. This flight experiment is a reflight of the solar array flight experiment, SAFE, except that three active solar array panels, electron release devices and plasma diagnostics are added. This experiment, SAFE 2, evaluates power loss due to parasitic current collected by the solar array, arcing on the solar array and perturbations to the plasma which may increase power loss and disturb plasma and charged particle science acquisition.

5555 **(ORNL/FEDC—83/2) Numerical simulation of the plasma current quench following a disruptive energy loss.** Strickler, D.J.; Peng, Y.K.M.; Holmes, J.A.; Miller, J.B.; Rothe, K.E. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 39p. NTIS, PC A03/MF A01. Order Number DE84003151.

The plasma electromagnetic interaction with poloidal field coils and nearby passive conductor loops during the current quench following a disruptive loss of plasma energy is simulated. By solving a differential/algebraic system consisting of a set of circuit equations (including the plasma circuit) coupled to a plasma energy balance equation and an equilibrium condition, the electromagnetic consequences of an abrupt thermal quench are observed. Limiters on the small and large major radium sides of the plasma are assumed to define the plasma cross section. The presence of good conductors near the plasma and a small initial distance (i.e., 5 to 10% of the plasma minor radius) between the plasma edge and an inboard limiter are shown to lead to long current decay times. For a plasma with an initial major radius R/sub o/ = 4.3 m, aspect ratio A = 3.6, and current I/sub P/ = 4.0 MA, introducing nearby passive conductors lengthens the current decay from milliseconds to hundreds of milliseconds.

5556 **(ORNL/FEDC—83/5) Engineering aspects of disruption current decay.** Murray, J.G. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01. Order Number DE84002995.

Engineering features associated with the configuration of a tokamak can affect the amount of energy that produces melting and damage to the limiters or internal wall surfaces as the result of a major disruption. During the current decay period of a major thermal disruption, the energy that can damage a wall or limiter comes from the external magnetic field. By providing a good conducting torus near the plasma and increasing the plasma circuit resistance, this magnetic energy (transferred by way of the plasma circuit) can be minimized. This report addresses engineering design features to reduce the energy deposited on the inner torus surface that produces melting of the structures.

5557 **(ORNL/TM—8861) Steepest descent moment method for three-dimensional magnetohydrodynamic equilibria.** Hirshman, S.P.; Whitson, J.C. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 82p. NTIS, PC A05/MF A01. Order Number DE84002993.

An energy principle is used to obtain the solution of the magnetohydrodynamic (MHD) equilibrium equation J Vector x B Vector - del p = 0 for nested magnetic flux surfaces that are expressed in the inverse coordinate representation x Vector = x Vector(rho, θ, zeta). Here, θ and zeta are poloidal and toroidal flux coordinate angles, respectively, and p = p(rho) labels a magnetic surface. Ordinary differential equations in rho are obtained for the Fourier amplitudes (moments) in the doubly periodic spectral decomposition of x Vector. A steepest descent iteration is developed for efficiently solving these nonlinear, coupled moment equations. The existence of a positive-definite energy functional guarantees the

monotonic convergence of this iteration toward an equilibrium solution (in the absence of magnetic island formation). A renormalization parameter λ is introduced to ensure the rapid convergence of the Fourier series for x Vector, while simultaneously satisfying the MHD requirement that magnetic field lines are straight in flux coordinates. A descent iteration is also developed for determining the self-consistent value for λ.

5558 **(PPPL—2049) Universality of the topology of period doubling dynamical systems.** Beiersdorfer, P. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Oct 1983. Contract AC02-76CH03073. 15p. NTIS, PC A02/MF A01. Order Number DE84003467.

The evolution of the topology of the invariant manifolds of the attractors of 3-D autonomous dynamical systems during period doubling is shown to be universal. The overall topology of the nth attractor is shown to depend only on the topology of the first attractor at birth.

5559 **(PPPL—2053) Multichannel euv spectroscopy of high temperature plasmas.** Fonck, R.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Nov 1983. Contract AC02-76CH03073. 37p. NTIS, PC A03/MF A01. Order Number DE84003468.

Spectroscopy of magnetically confined high temperature plasmas in the visible through x-ray spectral ranges deals primarily with the study of impurity line radiation or continuum radiation. Detailed knowledge of absolute intensities, temporal behavior, and spatial distributions of the emitted radiation is desired. As tokamak facilities become more complex, larger, and less accessible, there has been an increased emphasis on developing new instrumentation to provide such information in a minimum number of discharges. The availability of spatially-imaging detectors for use in the vacuum ultraviolet region (especially the intensified photodiode array) has generated the development of a variety of multichannel spectrometers for applications on tokamak facilities.

5560 **(PPPL—2054) Resistive stability of the cylindrical spheromak.** DeLucia, J.; Jardin, S.C.; Glasser, A.H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Nov 1983. Contract AC02-76CH03073. 52p. NTIS, PC A04/MF A01. Order Number DE84003498.

The growth rates for resistive instabilities in a straight circular cylinder with spheromak profiles are computed by using two complementary methods. The first method employs boundary layer analysis and asymptotic matching, most valid for values of the magnetic Reynolds number $S \geqq 10^5$. The second method solved the full linearized resistive MHD equations as an initial value problem, utilizing zone packing around the mode rational surface. Resolution requirements limit this to $S \leqq 10^7$. The results from these two methods agree to better than 1 in 10^3 in the overlap region $10^7 \geqq S \geqq 10^5$. A scan of parameter space reveals that for parabolic q-profiles, the least unstable configurations have q_0 R/a $\sim$ 0.67. The Hall term in Ohm's Law is easily incorporated into both methods. Recalculating the resistive MHD growth rates in the presence of this term shows that the resistive interchange mode is completely stabilized for a large enough value of the ion cyclotron time.

5561 **(SAI/APPAT—29) Studies in rf emission and absorption in EBT plasmas.** Tamor, S. (Science Applications, Inc., La Jolla, CA (USA)). Oct 1983. Contract W-7405-ENG-26. 24p. NTIS, PC A02/MF A01. Order Number DE84002118.

The effort was devoted primarily to development of a code for calculating absorption coefficients for electron distributions which are consistent with the adiabatic invariants and the magnetic field and pressure profiles. This work is almost complete. A smaller effort went into exploitation of the code already developed for absorption in anisotropic plasma, and into further studies related to synchrotron emission from EBT rings.

5562 **(UCRL—89319) Design of a separator/neutralizer to limit impurities and non-primary species in the Mirror Fusion Test Facility.** Goldner, A.I. (Lawrence Livermore National Lab., CA (USA)). 30 Nov 1983. Contract W-7405-ENG-48. 9p. (CONF-831203—13). NTIS, PC A02/MF A01. Order Number DE84003728.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

The optimum plasma for the tandem Mirror Fusion Test Facility (MFTF-B) at Lawrence Livermore National Laboratory (LLNL) is very sensitive to heavy contaminates, such as oxygen and metals. Unfortunately the current neutral beam sources generate not only high energy deuterium particles but also high energy oxygen particles. A new MFTF-B separator/neutralizer has been designed to filter out the unwanted oxygen and allow only primary species neutrals to reach the plasma.

5563 **Particle-induced thermonuclear fusion.** Salisbury, W.W. (to Occidental Research Corp.). US Patent 4,401,618. 30 Aug 1983. Filed date 27 Mar 1979. vp.

PAT-APPL-24314.

A nuclear fusion process is disclosed for igniting a nuclear fusion pellet in a manner similar to proposed for laser beams uses, an array of pulsed high energy combined particle beams focused to that bombard the pellet for isentropically compressing it to a Fermi-degenerate state by thermal blow-off and balanced beam momentum transfer. Each combined particle beam is arranged to produce electric charge neutrality in a volume around the target so that space charge induced expansion is avoided. Each high energy combined beam is produced by merging in neutralizing proportion a convergently focused stream of positive particles and at least one convergently focused stream of negative particles to form an electrically neutralized combined beam having a deBroglie wavelength focal pattern at the region of pellet collision. The momentum and fusible mass of the particle beams reduce the ablation loss and result in a larger fraction of the pellet being available for fusion reaction. Existing particle beam technology makes high energies and high production efficiencies feasible for reducing the power input and reactor size necessary for practical nuclear fusion power.

5564 **Confinement of pulse-injected external ions in magnetostatic and electrostatic ion traps.** Schuessler, H.A.; Chun-Sing, O. (Texas A & M Univ., College Station, TX 77843). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **30**: No. 2, 1468-1471(Apr 1983).

Numerical methods are used to evaluate the confinement properties of both a Penning ion trap and a purely electrostatic ion trap for pulsed ion injection from an external source. As an example the optimum time intervals for switching on the storage fields are obtained for singly charged ions of mass 100 u and with energies up to 100 eV. For the Penning trap only axial injection along the external magnetic field is feasible. In the case of the purely electrostatic trap both axial and radial-equatorial plane incidence directions are considered. It is shown that for both storage devices practically all ions in a pulse of one microsecond duration can be trapped with properly chosen time delays and injection parameters.

5565 **Several atomic physics issues connected with the use of neutral beams in fusion experiments.** Post, D.E.; Grisham, L.R.; Fonck, R.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Physica Scripta;* **T3**: 135-147(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

Energetic neutral beams are used for heating and diagnostics in present magnetic fusion experiments. Atomic physics issues are important for both the production of the neutral beams and the interaction of the beams and the plasma. Interest in neutral beams based on negative hydrogen ions is growing, largely based on advances in producing high current ion sources. The presence of neutral atoms in hot plasma can enhance the recombination rate of multiply-charged impurity ions, thus leading in some cases to large energy losses through impurity radiation. The radiation from the decay cascade of excited impurity ions produced by the charge exchange of neutral hydrogen beams and multiply-charged ions has

been developed into a powerful diagnostic technique for measuring the impurity levels in tokamaks. Neutral beams have also been proposed to measure the alpha particle distribution in the next generation of fusion experiments.

5566 **High resolution X-ray spectroscopy for diagnostics of single tokamak discharges.** Kaellne, E.; Kaellne, J. (Smithsonian Astrophysical Observatory, Cambridge, MA (USA)). *Physica Scripta;* **T3**: 185-190(1983). (CONF-8206110—).

From Symposium on production and physics of highly charged ions; Stockholm, Sweden (1 Jun 1982).

The authors report on an experiment which has been used to measure soft X-ray line emission spectra from highly charged impurity elements in the hot plasma of the Alcator C tokamak. These measurements shall serve as a diagnostic of plasma parameters: the temperature (of ions and electrons), the electron and impurity ion densities, and charge state distributions. Results from the initial measurements of the He- and H-like spectra of S and Cl are presented as well as spectra from molybdenum in charge states between Mo^{28+} and Mo^{32+}. Dependencies of the measured spectra on plasma parameters are provided. The aim of this experiment is to conduct broad-band time-resolved spectroscopic diagnosis of tokamak plasmas. To this end the authors discuss pertinent requirements of spectrometer performance and the development of a new position sensitive X-ray detector system.

5567 **Electromagnetic induction phenomena in plasma systems.** Karlovitz, B. (Combustion and Explosives Research, Inc., Pittsburgh, PA). *Nuclear Technology/Fusion;* **2**: No. 4, 617-622(Oct 1982).

The phenomenon of electromagnetic induction is considered in complex high temperature plasma systems. Thermal energy of such fully ionized plasma is really energy of the magnetic vortex fields surrounding the randomly moving ions and electrons. In an expanding plasma stream, moving across the containing magnetic field, random thermal motion of the ions and electrons is converted into ordered motion and thereby random magnetic energy of the plasma into magnetic energy of an ordered field. Consequently, in contrast to simple systems consisting of coils and magnets only, an expanding plasma stream can maintain net outflow of ordered magnetic energy from a closed volume for an indefinite length of time. Conversion of thermal energy of plasma into ordered magnetic energy by the thermodynamic expansion process leads to the expectation of a new induction phenomenon: the generation of a unidirectional induced electromotive force of unlimited duration, measured in a closed loop at rest relative to the magnetic field, by the expansion work of the plasma stream. No change is required in the differential form of Maxwell's equations for the existence of this induction phenomenon, only the definition of the concept of rate of change of magnetic flux needs to be modified in the macroscopic equations to correspond to the rate of flow of magnetic energy across a closed surface. An experimental test of the predicted induction phenomenon is proposed.

5568 **Electron cyclotron heating in weakly relativistic finite-beta tandem mirror plasmas.** Audenaerde, K.R.; Scharer, J.E. (University of Wisconsin, Madison, WI). *Nuclear Technology/Fusion;* **2**: No. 4, 623-636(Oct 1982). Contract AC02-80ER53104.

Electron cyclotron resonance frequency wave and absorption theory and ray tracing are reviewed and a numerical model for the study of electron heating in tandem mirror plugs and barriers is presented. It is found that substantial shifts in the spatial energy deposition profile occur from the cold plasma electron cyclotron resonance at elevated temperatures and that surface absorption can be substantial. The O-mode exhibits a ray trajectory that more easily penetrates to the plasma core and has an adequate single-pass absorption at temperatures >10 keV.

5569 **Neutral xenon beam for plasma diagnostics.** Hershcovitch, A.I.; Davenport, J.W.; Gammel, G.M. (Associated Universities, Inc., Brookhaven National Laboratory, Upton, New York 11973). *Nuclear Technology/Fusion;* **2**: No. 4, 700-706(Oct 1982).

A novel plasma diagnostic technique for simultaneous measurements of internal magnetic fields, ion temperature, and plasma potential is described. This technique consists of the injection of a 120-keV, 5-mA (current equivalent) neutral xenon beam into a magnetized plasma and the detection of radiation and xenon ions, which result from interaction of xenon atoms with hydrogen ions. This system is shown to be particularly suitable for devices like the Princeton Large Torus and other mainline machines.

5570 **Partially catalyzed deuterium and tritium-assisted plasma characteristics.** Greenspan, E.; Miley, G.H. (University of Illinois, Fusion Studies Laboratory, Nuclear Engineering Program, Urbana, Illinois 61801). *Nuclear Technology/Fusion;* **2**: No. 4, 590-608(Oct 1982).

Partially catalyzed deuterium (PCD) fuel cycles and their sensitivity to ash buildup, radiation losses, T /SUB i/ /T /SUB e/ and ^{3}He consumed are investigated. The study is machine independent, using a simple zero-dimensional steady-state model. The PCD fuel cycles include semi-catalyzed-deuterium where only a fraction of the ^{3}He fuses and tritium-catalyzed-deuterium where ^{3}He extracted from the plasma is converted into tritium, which is reinjected. Also considered is tritium-assisted operation where a fraction of the fusion neutrons is used to produce tritium, which is added to the PCD plasma. The PCD and tritium-assisted operation is shown to be attractive for certain nonelectrical applications. They avoid ^{3}He recirculation required for catalyzed deuterium (Cat-D) operation and enable simplified blanket designs. The ignition temperature, n /SUB epsilon/ /tau/, and power density of PCD plasmas are very energy balance sensitive, but under certain conditions these properties can be comparable or superior to those of Cat-D. Cyclotron radiation losses can significantly impair, whereas tritium assistance can strongly improve, PCD performance.

5571 **A phenomenological description of Rayleigh-Taylor and Helmholtz instabilities in small fusion targets.** Kirkpatrich, R.C. (Los Alamos National Laboratory, Los Alamos, New Mexico). *Nuclear Technology/Fusion;* **2**: No. 4, 707-711(Oct 1982).

Only rudimentary progress has been made toward a practical theory of instabilities and their effects in small fusion targets. This is partly because a practical theory must combine several complicated physical phenomena. Most analytic studies of small amplitude Rayleigh-Taylor instabilities have neglected rotational flow, and the transition to large amplitude (nonlinear) behavior is probably dependent on poorly known fluid properties. Also, heat transfer and conduction may provide stabilization under some circumstances, while shear flow leads to Helmholtz instability, and ultimately some degree of pusher fragmentation must occur. Several mechanisms may couple the instabilities to the deuterium-tritium (D-T). The chief concern is added energy loss from the D-T volume and may result from increased area of a distorted interface, the enhanced emission from the D-T due to impurities introduced by the instabilities, and energy deposition by the D-T alphas in the pusher material rather than in the D-T.

5572 **The stellarator approach to toroidal plasma confinement.** Johnson, J.L. (Princeton Univ., Plasma Physics Laboratory, Princeton, NJ). *Nuclear Technology/Fusion;* **2**: No. 3, 340-361(Jul 1982). Contract AC02-76CH03073.

An overview is presented of the development and current status of the stellarator approach to controlled thermonuclear confinement. Recent experimental, theoretical, and systems developments have made this concept a viable option for the evolution of the toroidal confinement program. Some experimental study of specific problems associated with departure from two-dimensional symmetry must be undertaken before the full advantages and opportunities of steady-state, net-current-free operation can be realized.

5573 **Simultaneous heating and confinement of two ion species for fusion by ion cyclotron resonance.** Roychowdhury, U.K.; Graham, R.; Pool, M.L. (Western Illinois, Dept. of Chemistry and Physics, Macomb, IL). *Nuclear Technology/Fusion;* **2**: No. 3, 392-397(Jul 1982).

A quadrupole coil that produces an inwardly convex curvature of the induced electric field lines and low induced magnetic

fields in the plasma zone has been constructed. Hydrogen and boron plasmas were produced by the use of such a coil. Faraday cup measurements showed that the maximum proton energy in the loss cone of a magnetic bottle was 630 eV. Two such quadrupole coils were oriented to have nearly zero mutual inductance. Energy was imparted independently by ion cyclotron resonance to two different species in a plasma in a common dc magnetic field. A diborane plasma was produced by simultaneous operation of the two coils and the 2497-A boron I line identified. The energy was supplied directly to protons and to boron ions. The quadrupole coil appears to be promising as a primary or supplementary heating source for certain fusion devices of the magnetic bottle type.

5574 **Plasma heating with multi-MeV neutral atom beams.** Grisham, L.R.; Eubank, H.P.; Mikkelsen, D.R.; Post, D.E. (Princeton University, Plasma Physics Laboratory, Princeton, NJ). *Nuclear Technology/Fusion;* **2**: No. 2, 199-214(Apr 1982). Contract AC02-76CH03073.

The authors explore the utility and feasibility of neutral beams of A $\geqq$ 6 amu formed from negative ions, and also of D^0 formed from D^-. The negative ions would be accelerated to about 1 to 2 MeV/amu and neutralized, whereupon the neutral atoms would be used to heat and perhaps to drive current in magnetically confined plasmas. Such beams appear feasible and offer the promise of significant advantages relative to conventional neutral beams based on positive deuterium ions at about 150 keV.

5575 **Possible nonhydrogen neutralizers for high energy D^+ and H^+ beams.** Grisham, L.R. (Princeton University, Plasma Physics Laboratory, Princeton, NJ). *Nuclear Technology/Fusion;* **2**: No. 1, 104-109(Jan 1982).

The authors explore (the utility of using a gas other than hydrogen isotopes to neutralize energetic beams of D^+ or H^+ for applications in magnetic confinement fusion. They find that, at D^+ energies above 160 keV, helium, relative to hydrogen, offers significant improvements in neutralization efficiency and in enrichment of the full energy component of the beam, and that similar advantages accrue with neon at D^+ energies in excess of 200 keV.)

5576 **Deuterium-based plasmas as a source for helium-3.** Greenspan, E.; Miley, G.H. (Univ. of Illinois, Fusion Studies Laboratory, Nuclear Engineering Program, Urbana, IL). *Nuclear Technology/Fusion;* **2**: No. 1, 43-54(Jan 1982).

The maximum fraction of ^{3}He recoverable from deuterium-based plasmas (to fuel D-^{3}He fusion reactors) is investigated, and optimal plasma conditions are identified. The upper bound to the fraction of ^{3}He recoverable from ignited plasmas is ca.80%, corresponding to one ^{3}He atom per 50 MeV of fusion energy, but recovery efficiency is very sensitive to the plasma energy balance. Effects of enhanced radiation losses, tritium assistance, ion/electron temperature split, plasma temperature and density profiles, and external plasma heating are examined. It appears possible to recover ca. 70% of the ^{3}He produced in realistic driven semi-catalyzed deuterium (SCD) plasmas, at 70 MeV per atom. This suggests interesting possibilities for the symbiosis of SCD synfuel factories with satellite D-^{3}He reactors for the generation of electricity.

5577 **Some aspects of the interaction of electromagnetic radiation with laser-produced plasmas.** Montes, A. Oxford, England; Oxford University (1980). 130p. British Library, Boston Spa, Wetherby, West Yorks. No. D36488/81.

Thesis (Ph.D.).

Some problems related to the laser energy absorption, plasma heating and heat transport in the interaction of intense electromagnetic radiation with laser-produced plasmas are investigated and ponderomotive force effects considered.

5578 **Water-bag model. An analytical study of linear plasmas.** Kafetzis, A.T. Coventry, England; Warwick University (1977). 91p. British Library, Boston Spa, Wetherby, West Yorks. No. D36809/81M.

Thesis (Ph.D.).

Some basic linear problems of a collisionless plasma are considered using the so-called 'water-bag' model. The dispersion relations for a single and a double 'water-bag' are given and comparisons with the closed-moment model are made. The effects of an external applied electric field are considered and the trapping of particles within the potential troughs analysed.

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REFER ALSO TO CITATION(S) 4503, 4860, 4860, 4943, 4944, 4945, 4947, 4948, 4949, 4950, 4951, 4952, 4953, 4954, 4955, 4956, 4958, 4959, 4960, 4961, 4962, 4963, 4964, 4965, 4966, 4967, 4968, 4969, 4970, 4970, 4971, 5102, 5312, 5570

5579 **(BNL—33865) Fusion blanket high-temperature heat transfer.** Fillo, J.A. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 8p. (CONF-831111—12). NTIS, PC A02/MF A01. Order Number DE84002868.

From ASME winter annual meeting; Boston, MA, USA (13 Nov 1983).

Portions are illegible in microfiche products.

Deep penetration of 14 MeV neutrons makes two-temperature region blankets feasible. A relatively low-temperature (~ 300°C) metallic structure is the vacuum/coolant pressure boundary, while the interior of the blanket, which is a simple packed bed of nonstructural material, operates at very high temperatures (>1000°C). The water-cooled shell structure is thermally insulated from the steam-cooled interior. High-temperature steam can dramatically increase the efficiency of electric power generation, as well as produce hydrogen and oxygen-based synthetic fuels at high-efficiency.

5580 **(CONF-830795—4) Modification of alloy surface composition by segregation processes as a means of impurity control in fusion devices.** Krauss, A.R.; Gruen, D.M.; DeWald, A.B. (Argonne National Lab., IL (USA); Georgia Inst. of Tech., Atlanta (USA). Nuclear Engineering Dept.). 1983. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01. Order Number DE84003645.

From Symposium on energy removal and particle control and toroidal fusion devices; Princeton, NJ, USA (26 Jul 1983).

We are investigating the use of surface segregation in alloys as a means of producing low Z coatings which are self-sustaining in a reactor environment, present no thermal barrier to the substrate, and avoid mechanical problems associated with the interface region. Several candidate materials have emerged from our calculations, including alloys of copper, vanadium and tungsten. The segregation calculations, light and heavy ion sputtering properties and thermodynamic properties of these materials are presented. Calculations indicate that as little as one atomic layer of low Z material significantly reduces the substrate erosion for both light and heavy ion sputtering. Experimental data on the degree of surface segregation and the rate at which the low Z component migrates to the surface are presented using dilute alloys of litium in copper as a reference system. The long term stability of the overlayer is limited primarily by the rate at which radiation-enhanced diffusion can replace the eroded surface material. The radiation-enhanced process proceeds much more quickly than the purely thermodynamic process and depends on the damage profile, which in turn depends on the mass and energy spectrum of the incident radiation.

5581 **(CONF-830942—61) Issues in strategy for an irradiation program on fusion structural materials.** Nygren, R.E. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE84003625.

From 3. topical meeting on fusion reactor materials; Albuquerque, NM, USA (19 Sep 1983).

Portions are illegible in microfiche products.

This paper summarizes major issues in evaluating the use of advanced fusion devices as the principal radiation sources for the development of structural materials for commercial fusion reactors and focuses on work performed for the 1982 FED/INTOR study in the Engineering Testing task. The general objective of this task was to estimate the benefit for a DEMO reactor resulting from irradiation tests on structural materials in an engineering reactor (e.g. FED/INTOR). Some background information on radiation sources is also presented.

5582 **(DOE/DP/40124—9) Software clock-divider.** Pruitt, C. (Rochester Univ., NY (USA). Lab. for Laser Energetics). 1983. Contract AC08-80DP40124. 15p. NTIS, PC A02/MF A01. Order Number DE84001266.

An A/D converter is to be sampled twice per second. A line-clock interrupt is available sixty times per second, but the sampling routine takes longer than a sixtieth of a second to run. The solution is a clock-interrupt handler that updates time-of-day, then if half a second has elapsed, allows interrupts (including itself) to be serviced while the sampling routine runs. Except for a small amount of set-up and exit code, everything can be written in Forth.

5583 **(DOE/ER—0045/10) Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.** (Oak Ridge National Lab., TN (USA)). Oct 1983. Contract W-7405-ENG-26. 216p. NTIS, PC A10/MF A01. Order Number DE84002405.

Separate abstracts were prepared for 34 of the included sections. (MOW)

5584 (DOE/ER—0045/10, pp 5-9) **Assessment of martensitic stainless steels for low activation status.** Lechtenberg, T.A. (GA Technologies, San Diego, CA). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

A design equation gives allowable amounts of impurities in martensitic steels with 12% Cr, to permit trade-off of strengthening agents when some additions produce unacceptable levels of impurities.

5585 (DOE/ER—0045/10, pp 12-18) **Neutron source characterization for materials experiments.** Greenwood, L.R. (Argonne National Lab., IL). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

Neutron fluxes and energy spectra agree quite well for HFIR irradiations CTR-31, -32, -34, and -35. Reaction rates in CTR-32 were corrected by improved burnup calculations. Helium production is being revised slightly because of new ^{59}Ni cross sections. Dosimetry for several irradiation experiments is summarized.

5586 (DOE/ER—0045/10, pp 19-20) **Neutronic calculations in support of the ORR-MFE-4 spectral tailoring experiments.** Lillie, R.A.; Gabriel, T.A. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

New scaling factors have been obtained to force agreement between the experimentally measured and calculated fluences. As of March 31, 1983, these factors yield 89.6 at. ppM He (not including 2.0 at. ppM He from ^{10}B) and 6.18 dpa for type 316 stainless steel in ORR-MFE-4A and 57.7 at. ppM He and 4.48 dpa in ORR-MFE-4B.

5587 (DOE/ER—0045/10, pp 21-22) **Operation of the ORR spectral tailoring experiments ORR-MFE-4A and ORR-MFE-4B.** Conlin, J.A.; Dudley, I.T.; Lees, E.M. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development of irradiation performance. Semiannual progress report for period ending March 31, 1983.

The specimens contained in the ORR-MFE-4A experiment have been in reactor for an equivalent of 529.3 d at 30 MW reactor power, with temperatures of 400 and 330°C. The ORR-MFE-4B experiment, with specimen temperatures of 500 and 600°C, has operated for an equivalent of 424 d at 30 MW reactor power. It was removed from the reactor October 21, 1982, for specimen inspection and transfer to a new capsule.

5588 (DOE/ER—0045/10, pp 176-181) **Irradiation experiment status and schedule.** Grossbeck, M.L. (Oak Ridge National Lab., TN). Oct 1983. NTIS, PC A10/MF A01.

In Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1983.

A large number of planned, in-progress, and completed reactor irradiation experiments support the ADIP program. A table summarizes the parameters that describe completed experiments. Experiments that have been removed from the reactor only recently, are currently undergoing irradiation, or are planned for future irradiation are included in schedule bar charts.

5589 **(ECN—132) Fusion technology program. Semiannual report July-December 1982.** Elen, J.D. (Stichting Energieonderzoek Centrum Nederland, Petten). Mar 1983. 57p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703846.

For the NET/INTOR design study, some detailed analyses were made concerning the impact of plasma disruptions on the first wall and the consequence of loss of coolant or loss of coolant flows in the blanket modules. Substantial progress has been made in the calculations of correlated angle-energy distributions of non-elastic cross sections at incident neutron-energies above 10 MeV. A new version of the precompound model has been developed. A step towards further unification of the statistical Hauser-Feshbach model and the precompound model has been made by a coupling between the two models. The consequences of using a ternary Li-Pb-X alloy in the liquid breeder blanket of INTOR were studied. Ten possible additions were classified according to their influence on neutron multiplication. Samples of stainless steel-316 are irradiated in the core of the HFR reactor. Vanadium-titanium alloys with a range of ^{10}B additions have been produced. Tensile specimens and irradiation capsules were fabricated. The fabrication of the 8T niobium-titanium magnet coil for the superconductor test facility SULTAN at Villigen was completed. In collaboration with the Swiss SIN and the Italian ENEA an extension of the SULTAN facility to 12 T has been planned. The extension will consist of three additional coils of 5 kA niobium-tin and niobium-aluminium conductors. Finally, the results of a conductor design study for the toroidal field coils of NET/INTOR are reported.

5590 **(EUR-CEA-FC-RA—1981) Annual progress report 1981.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee). 1982. 58p. (In French). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83703847.

The most important decision in the life of the Association in 1981 was the final commitment to the Tore Supra programme, a decision which allowed the effective advance to the construction phase at Cadarache. Another general feature of the programme is the growing importance of international collaboration, especially European. The most important in volume concerns the JET and Garching IPP, which continue their already old and well-established relations. Others exist with Sweden, Denmark, the JRC/Ispra Centre, the United Kingdom, and the INTOR and NET projects. The Fontenay aux Roses TFR program is increasingly oriented towards HF heating by ion cyclotron resonance and the HF divertor, and also towards fundamental problems of transport, fluctuations and disruptions. The HF heating at low hydrid resonance will be resumed in Grenoble on the Petula Tokamak which was radically changed and improved, and which was successfully restarted in December 1981. Moreover, the joint Franco-German programme on the Wega Tokamak in Grenoble was stopped at the end of 1981, after having obtained significant results on HF power transmission. The development of ion sources and intense beams continued successfully in Fontenay aux Roses for applications to ASDEX and to JET, and these results will also be invaluable for the Tore Supra project. The theoretical research grouped in a special chapter of the report covers a vast spectrum of investigations, ranging from pure theory to that associated directly with the experimental programme and dealing with a large number of problems.

5591 **(JAERI-M—9775) Report of workshop on particle material interactions for fusion research.** Gesi, Kazuo; Iwata, Tadao; Ozawa, Kunio; Shiraishi, Kensuke (eds.). (Japan Atomic Energy Research Inst., Tokyo). Nov 1981. 156p. (CONF-810189—). NTIS (US Sales Only), PC A08/MF A01. Order Number DE84780036.

From Workshop on the particle material interaction for fusion research; Tokyo, Japan (12 Jan 1981).

Separate abstracts were prepared for papers from this workshop on particle-material interactions for fusion research. (KAW)

5592 **(LA-UR—83-3439) Stellarator helical vacuum vessel.** Yavornik, E.J. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-831203—11). NTIS, PC A02/MF A01. Order Number DE84003815.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

A design study of a stainless steel, heavy wall, helically shaped vacuum torus has been made for use in a proposed Stellarator configuration. The study concerns itself with the shape of the vacuum vessel and the division of the vessel into components that can be machined and welded together into a helical configuration. A complication in the design requires that a circular magnet coil be located at the minor toroidal axis and that this coil be embedded within the periphery of the vacuum vessel. The vacuum vessel has a minor toroidal axis diameter of 4 meters, a 68.6-cm shell diameter, and a 1.9-cm wall thickness. It twists about the minor toroidal axis twice in 360°C. (An n value of 2). It is proposed that the unit be made of cylindrical segments with the ends of the cylinders cut at appropriate lengths and angles to form the helix. A mathematical derivation of the dimensions necessary to produce the required shapes of the segments has been made. Also, drawings of the vacuum vessel components have been produced on LANL's CTR CAD/CAM system. The procedure developed can be used for any value of n as dictated by physics requirements.

5593 **(LA-UR—83-3452) Conceptual design for an air core 2 meg-amp reversed field experiment.** Hammer, C.F. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 5p. (CONF-831203—6). NTIS, PC A02/MF A01. Order Number DE84003844.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

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The Los Alamos CTR Division is involved in the conceptual design of a next phase Reversed Field Pinch experiment. The paper will discuss, in general, some of the physics questions that the experiment will address. Also in more detail it will discuss the engineering parameters and the possible hardware design solutions. The experiment is designed to produce a plasma current of about 2 MA which can be sustained for about 200 ms. The electrical energy for the system is provided by a large motor generator set. An inductive energy store is used to drive the magnetizing and poloidal field windings. A capacitor bank provides the energy for the toroidal field windings. The current in both circuits is maintained by using SCR controlled transformer rectifiers.

5594 **(NRL-MR—5174) X-ray production in long-scalelength laser-plasma interaction experiments.** Young, F.C.; Herbst, M.J.; Gardner, J.H.; Kearney, K.J.; Stamper, J.A.; Obenschain, S.P.; Grun, J.; McLean, E.A.; Ripin, B.H. (Naval Research Lab., Washington, DC (USA)). 4 Nov 1983. Contract AI08-79DP40092. 13p. (CONF-8306142—1). NTIS, PC A02/MF A01. Order Number DE84002472.

From 13. annual anomalous absorption conference; Banff, Canada (5 Jun 1983).

The interaction of a high intensity laser beam ($I \geq 10^{14}$ W/cm^2) with long-scalelength plasmas (absolute value of n/sub e/del n/sub e/ $\leqq$ 400 μm at 0.1 critical density) is being studied experimentally by using two beams from the Pharos II Nd laser (λ = 1.054 μm). A low-intensity defocused beam of 4-nsec duration produces background plasmas of variable scalelength from a solid plastic target. A 0.3-nsec focused beam timed to arrive on target near the peak of the long pulse interacts with this long-scalelength plasma. Temporally and spatially integrated bremsstrahlung intensities from 1 to 50 keV are measured. X-ray spectra deduced from the measurements are used to evaluate target heating (based on 1 to 5 keV x-rays) and to determine the relative importance of energetic electron production by plasma instabilities in the underdense region (based on 10 to 50 keV x-rays).

5595 **(ORNL/FEDC—83/3) System studies for quasi-steady-state advanced physics tokamak.** Reid, R.L.; Peng, Y.K.M. (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 66p. NTIS, PC A04/MF A01. Order Number DE84002996.

Parametric studies were conducted using the Fusion Engineering Design Center (FEDC) Tokamak Systems Code to investigate the impact of veriation in physics parameters and technology limits on the performance and cost of a low q/sub psi/, high beta, quasi-steady-state tokamak for the purpose of fusion engineering experimentation. The features and characteristics chosen from each study were embodied into a single Advanced Physics Tokamak design for which a self-consistent set of parameters was generated and a value of capital cost was estimated.

5596 **(SAND—83-1346C) Materials requirements for high heat flux components.** Gauster, W.B.; Koski, J.A.; Watson, R.D. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 12p. (CONF-830942—60). NTIS, PC A02/MF A01. Order Number DE84002170.

From 3. topical meeting on fusion reactor materials; Albuquerque, NM, USA (19 Sep 1983).

Portions are illegible in microfiche products.

In-vessel components in all types of fusion devices are exposed to both high heat and high particle fluxes. Increased pulse lengths and high levels of auxiliary heating power in machines now coming on line and in various states of planning pose new demands on materials. The requirements of heat removal combined with constraints posed by plasma-materials interactions lead to problems of materials selection, development, characterization, fabrication and testing. Specifications for components in current and future machines are summarized, and heat removal technology in regimes applicable to fusion components is reviewed. Possible solutions to materials problems encountered in the design of high heat flux components are shown in a review of some recent pump-limiter design studies. Finally, development needs and some of the test facilities being developed to help address them are discussed.

5597 **(SAND—83-2382C) Light ion beam fusion research at Sandia National Laboratories.** Yonas, G. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 17p. (CONF-831130—1). NTIS, PC A02/MF A01. Order Number DE84002109.

From Technical committee meeting on inertial confinement fusion research; Osaka, Japan (7 Nov 1983).

Data has been collected on PBFA I using three related diode types: (1) the Ampfion diode, (2) the applied field diode, and (3) the pinch reflex diode. Concurrent with these PBFA I experiments, complementary experiments were carried out on Proto I at Sandia, as well as the Lion accelerator at Cornell University, and the Gamble II accelerator at the Naval Research Laboratory. In addition to these experiments, improved electromagnetic particle-in-cell codes and analytical treatments were brought to bear on improving our understanding of diode phenomena. A brief review of some of the results is given.

5598 **(UCID—19910) Concept for a volume-type tandem three-chamber negative hydrogen ion source.** Leung, K.N.; Ehlers, K.W.; Hiskes, J.R. (Lawrence Livermore National Lab., CA (USA)). 25 Oct 1983. Contract W-7405-ENG-48. 9p. NTIS, PC A02/MF A01. Order Number DE84003338.

Two recent development in the volume generation and the volume extraction of negative ions are discussed that lead in a natural way to a new concept for direct-extraction volume-type negative-hydrogen ion source.

5599 **(UCRL—15555) Magnetic mirror fusion power systems.** Gordon, J.D.; Logan, B.G. (Lawrence Livermore National Lab., CA (USA); TRW Energy Systems Group, Redondo Beach, CA (USA)). 15 Sep 1983. Contract W-7405-ENG-48. 5p. (CONF-8303105—1). NTIS, PC A02/MF A01. Order Number DE84002799.

From 11. energy technology conference; Washington, DC, USA (19 Mar 1983).

5600 **(UCRL—89020) Silicon switch development for optical pulse generation in fusion lasers at Lawrence Livermore National Laboratory.** Wilcox, R.B. (Lawrence Livermore National Lab., CA (USA)). 12 Jul 1983. Contract W-7405-ENG-48. 6p. (CONF-830874—31). NTIS, PC A02/MF A01. Order Number DE84002798.

From 27. annual international technical symposium on high speed photography, videography and photonics; San Diego, CA, USA (21 Aug 1983).

We have been developing a silicon photoconductive switch for use as a Pockels cell driver in the pulse generation systems of the fusion lasers Nova and Novette. The objective has been to make 10 kV switches repeatably and which are reliable on an operating system. We found that nonlinear phenomena in nearly intrinsic silicon caused excessive conduction at high voltage resulting in breakdown. Our experiments with doped material show that this problem can be eliminated, resulting in useful devices.

5601 **(UCRL—89073) Proton shadow camera using CR-39 track detectors.** Stone, G.F.; Ceglio, N.M. (Lawrence Livermore National Lab., CA (USA)). 1 Sep 1983. Contract W-7405-ENG-48. 6p. (CONF-830969—9). NTIS, PC A02/MF A01. Order Number DE84002461.

From 12. international conference on solid state nuclear track detectors; Acapulco, Mexico (4 Sep 1983).

We have developed a capability for imaging proton sources of moderate energy (6 MeV), with moderate spatial resolution ($\simeq 9$ μm), as a diagnostic for laser fusion research. Our technique involves the use of Fresnel zone plate coded imaging coupled with nuclear track detectors (CR-39). We report on a series of test experiments in which a zone plate shadow camera successfully produced images of a proton source distribution. The zone plate shadow patterns were optically reconstructed in higher order producing diffraction-limited point response images with FWHM values of $\simeq 9$ μm for a 6 MeV proton source.

5602 **(UCRL—89171) Performance of the MFTF magnet cryogenic power leads.** VanSant, J.H. (Lawrence Livermore National Lab., CA (USA)). 30 Nov 1983. Contract W-7405-ENG-48. 6p. (CONF-831203—8). NTIS, PC A02/MF A01. Order Number DE84003722.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

The cryogenic power lead system for the MFTF superconducting magnets has been acceptance tested and operated with the magnets. This system, which includes 5-m-long superconducting buses, 1.5-m-long vapor-cooled transition leads, external warm buses, and a cryostack, can conduct up to 6000 A (dc) and operate adiabatically for long periods. We present both design details and performance data; our MFTF version is an example of a reliable lead system for large superconducting magnets contained in a much larger vacuum vessel.

5603 **(UCRL—89231) Gas box control system for Tandem Mirror Experiment-Upgrade.** Bell, H.H. Jr.; Hunt, A.L.; Clower, C.A. Jr. (Lawrence Livermore National Lab., CA (USA)). 14 Nov 1983. Contract W-7405-ENG-48. 6p. (CONF-831203—4). NTIS, PC A02/MF A01. Order Number DE84003245.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

The Tandem Mirror Experiment-Upgrade (TMX-U) uses several methods to feed gas (usually deuterium) at different energies into the plasma region of the machine. One is an arrangement of eight high-speed piezo-electric valves mounted on special manifolds (gas box) that feed cold gas directly to the plasma. This paper describes the electronic valve control and data acquisition portions of the gas box, which are controlled by a desk-top computer. Various flow profiles have been developed and stored in the control computer for ready access by the operator. The system uses two modes of operation, one that exercises and characterizes the valves and one that operates the valves with the rest of the experiment. Both the valve control signals and the pressure transducers data are recorded on the diagnostics computer so that they are available for experiment analysis.

5604 **(UCRL—89234) Design and fabrication of circular and rectangular components for electron-cyclotron-resonant heating of tandem mirror experiment-upgrade.** Felker, B.; Calderon, M.O.; Chargin, A.K.; Coffield, F.E.; Lang, D.D.; Rubert, R.R.; Pedrotti, L.R.; Stallard, B.W.; Gallagher, N.C. Jr.; Sweeney, D.W. (Lawrence Livermore National Lab., CA (USA); TRW, Inc., Redondo Beach, CA (USA)). 18 Nov 1983. Contract W-7405-ENG-48. 8p. (CONF-831203—2). NTIS, PC A02/MF A01. Order Number DE84003244.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

The electron-cyclotron-resonant heating (ECRH) systems of rectangular waveguides on Tandem Mirror Experiment-Upgrade (TMX-U) operated with a overall efficiency of 50%, each system using a 28-GHz, 200-kW pulsed gyrotron. We designed and built four circular-waveguide systems with greater efficiency and greater power-handling capabilities to replace the rectangular waveguides. Two of these circular systems, at the 5-kG second-harmonic heating locations, have a total transmission efficiency of $>90\%$. The two systems at the 10-kG fundamental heating locations have a total transmission efficiency of 80%. The difference in efficiency is due to the additional components required to launch the microwaves in the desired orientation and polarization with respect to magnetic-field lines at the 10-kG points. These systems handle the total power available from each gyrotron but do not have the arcing limitation problem of the rectangular waveguide. Each system requires several complex components. The overall physical layout and the design considerations for the rectangular and circular waveguide components are described here.

5605 **(UCRL—89243) Magnetic design of the axisymmetric throttle-coil addition to the tandem mirror experiment-upgrade.** Wong, R.L. (Lawrence Livermore National Lab., CA (USA)). 28 Nov 1983. Contract W-7405-ENG-48. 7p. (CONF-831203—9). NTIS, PC A02/MF A01. Order Number DE84003721.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

The TMX-U magnet set has incorporated new axisymmetric throttle coils and fan-reversing transition magnets. This new magnet geometry, which will allow for the experimental verification of new physics issues related to axicell tandem mirrors, encompasses both engineering and physics considerations. Engineering considerations include structural integrity plus neutral beam and diagnostic access. Physics issues include the stability and radial transport of the confined plasma. We have calculated the magnetic field using the magnetic field code, EFFI, and the plasma stability and surface curvatures using the plasma stability code, TEBASCO. Our magnet design allows the axisymmetric throttle mirror to be varied from the end-cell mirror value of 2 to a peak of 6 T.

5606 **(UCRL—89259) Review of MFTF yin-yang magnet displacement and magnetic field measurements and calculations.** Hanson, C.L.; Myall, J.O.; Wohlwend, J.W. (Lawrence Livermore National Lab., CA (USA); General Dynamics/Convair, San Diego, CA (USA)). 21 Nov 1983. Contract W-7405-ENG-48. 7p. (CONF-831203—12). NTIS, PC A02/MF A01. Order Number DE84003724.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

During the recent testing of the MFTF yin-yang magnet, measurements of coil position, structural case strain, and magnetic field were made to verify calculated values. Measurements to detect magnet movement were taken throughout cooldown and during the operation of the magnet. The magnetic field at the mirror points was measured by Hall-effect probes. The magnet position, structural case strain, and magnetic field measurements indicated a reasonably close correlation with calculated values. Information obtained from the yin-yang test has been very useful in setting realistic mechanical alignment values for the new MFTF-B magnet system.

5607 **(UCRL—89264) Review of the Tandem Mirror Experiment-Upgrade (TMX-U) machine-parameter-instrumentation system.** Kane, R.J.; Coffield, F.E.; Coutts, G.W.; Hornady, R.S. (Lawrence Livermore National Lab., CA (USA)). 15 Nov 1983. Contract W-7405-ENG-48. 6p. (CONF-831203—3). NTIS, PC A02/MF A01. Order Number DE84003243.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

The Tandem Mirror Experiment-Upgrade (TMX-U) machine consists of seven major machine subsystems: magnet system, neutral beam system, microwave heating (ECRH), ion heating (ICRH), gas fueling, stream guns, and vacuum system. Satisfactory performance of these subsystems is necessary to achieve the experimental objectives planned for TMX-U operations. Since the performance quality of the subsystem is important and can greatly affect plasma parameters, a 233-channel instrumentation system has been installed. Data from the instrumentation system are acquired and stored with the plasma diagnostic information. Thus, the details of the machine performance are available during post-shot analysis. This paper describes all the machine-parameter-instrumentation hardware, presents some typical data, and outlines how the data are used.

5608 **(UCRL—89304) Mirror fusion vacuum technology developments.** Batzer, T.H.; Call, W.R. (Lawrence Livermore National Lab., CA (USA)). 21 Nov 1983. Contract W-7405-ENG-48. 6p. (CONF-831203—10). NTIS, PC A02/MF A01. Order Number DE84003725.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

Magnetic Mirror Fusion experiments, such as MFTF-B+T (Mirror Fusion Test Facility-B, Tritium Upgrade) and foreseeable follow-on devices, have operational and maintenance requirements that have not yet been fully demonstrated. Among those associated with vacuum technology are the very-high continuous-pumping speeds, 10^7 to 10^8 l/s for D_2, T_2 and, to a lesser extent, He; the early detection of water leaks from the very-high heat-flux neutral-beam dumps and the detection and location of leaks in the superconducting magnets not protected by guard vacuums. Possible solutions to these problems have been identified and considerable progress has been made toward successfully demonstrating their feasibility.

5609 **(UCRL—89931) Trim coils and magnet alignment in MFTF-B.** Yamaguchi, G.T.; Baldwin, D.E. (Lawrence Livermore National Lab., CA (USA)). 23 Nov 1983. Contract W-7405-ENG-48. 7p. (CONF-831203—7). NTIS, PC A02/MF A01. Order Number DE84003730.

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

Performance of the MFTF-B tandem mirror reactor is critically dependent upon precise alignment of the superconducting magnets in the transition region. Given the size and nature of these magnets, mechanical alignment under operating conditions to the tolerances required is an impossible task, as placement must anticipate deflections due to vacuum conditions, cooling to cryogenic temperatures, and magnetic forces. A cost-effective solution to the alignment problem is presented here. In each transition region, a set of eight trimming magnets capable of introducing dipole- and quadrupole-field components allows the field curvatures to be finely tuned to offset the effects of mechanical alignment errors. Trimming current values for correcting representative single- and multiple-coil misalignments, as well as an analytic method for determining them are given. Finally, design considerations that will minimize the need for trim coils in future tandem mirror devices are suggested.

5610 **Computer simulation of multiple-beam final focusing systems for heavy ion fusion.** Habner, I. (Naval Research Lab., Washington, DC 20375). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2616-2617(Aug 1983). (CONF-830311—).

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Heavy Ion Fusion ignition systems which employ multiple beams to achieve the required ignition energies on a target offer a number of advantages over systems with a small number of beams. In addition to the higher phase space densities which can be transported, the use of multiple lenses reduces the chromatic and geometric aberrations in the final focusing system. Computer simulations are described here which show that, at least for a modest number of beams, the transverse space charge interaction between adjacent beams does not appear to cause significant final spot aberrations for parameters consistent with pellet ignition requirements.

5611 **Neutronic, photonic and thermal calculations relevant to a major plasma disruption in a canister-type tokamak blanket.** Onega, R.J.; Su, B.M. (Virginia Polytechnic Institute and State University Nuclear Engineering Group, Mechanical Engineering Department Blacksburg, Virginia 24061). *Nuclear Technology/Fusion;* **2**: No. 4, 667-686(Oct 1982).

Calculation of the steady-state neutron, photon, and temperature distributions as well as the transient thermal distribution following a major plasma disruption (MPD) in the first wall and blanket region of an engineering type of controlled thermonuclear reactor was made. A canister blanket design was considered and both the incident neutron and secondary gamma-ray heating were used in calculating the volumetric heat source rate. An average value of the volumetric heat source rate was calculated to be about 0.5 MW/m^3 and the neutron wall loading was 2.38 MW/m^2. After steady-state conditions were obtained, major plasma disruption times of 10 and 24 ms were assumed for the transient calculations. For each case, a constant velocity model was assumed for the surface heat flux impinging on the first wall during an MPD. Neutronic studies using the ANISN code provided volumetric heat source rates that were used to do the thermal analysis. A heat conduction code, HEATING5, was run for the steady-state temperature distribution. It was run again for the transient thermal study. Results show that there is a possibility of melting portions of the first wall if the disruption time of 10 ms is used, while no melting is possible for the 24-ms case; however, a maximum transient temperature of about 1000°C on the first wall does occur. The temperature in the blanket region remained the same as before the MPD since the transient takes place so rapidly that the effects were felt most by the first wall. The average number of abortions allowed before failure of the first wall was 200 thermal cycles for the 24-ms case.

5612 **Studies of the physics and engineering of deuterium-deuterium barrier tandem mirror reactors.** Conn, R.W.; Dhir, V.K.; Ghoniem, N.M.; Goebel, D.M.; Grotz, S.P.; Kantrowitz, F.; Kim, T.K.; Shuy, G.W.; Youssef, M.Z. (University of California, Los Angeles School of Engineering and Applied Science, Los Angeles, California 90024). *Nuclear Technology/Fusion;* **2**: No. 4, 563-589(Oct 1982). Contract AT03-80ER52061.

A study of barrier tandem mirrors as deuterium-deuterium (D-D) cycle reactors shows that high central cell beta and axisymmetry are crucial to even a moderate Q reactor. The SATYR system is large, with low-power density, and Q about 5 to 6. A specialized axisymmetric configuration involving a plugbarrier cell with a levitated internal ring has been developed, though overall results are independent of the specific axisymmetric end plug configuration. The internal ring thermal analysis, including both surface and neutron volumetric heating, revealed unexpectedly that the operating time between recooling periods is limited by the time to reach the temperature limit of the superinsulator rather than the time for the superconductor to reach some predetermined level (e.g., 12 K for Nb-Ti). Further, it is found that a melt-layer within the ring is not required. A new pressure-vessel-type blanket design with pebble beds of ferritic steel produces high blanket multiplication and has long life (exceeding plant life). Specific subjects analyzed include reactor plasma performance, magnetic configuration development, coil design, blanket nuclear analysis and thermal hydraulics, blanket materials, structural analyses, and lifetime. A detailed comparison of economic, environmental, and safety scaling factors for D-D and deuterium-tritium (D-T) reactors reveals few incentives for aiming at D-D devices. It is concluded that the linearity of tandem mirrors, their inherent modularity and potential for steady-state operation, their predicted high-power density and high Q value, suggest that optimized D-T-cycle barrier tandem mirror reactors with axisymmetry and high β /SUB c/ have the

potential to be economic reactor systems and should remain the major goal of mirror fusion research.

5613 **Impact of cross-section uncertainties on the nuclear design of hybrid reactors.** Youssef, M.Z.; Conn, W.; Maynard, C.W. (University of California-Los Angeles, School of Engineering and Applied Science, Los Angeles, California 90024). *Nuclear Technology/Fusion;* 2: No. 4, 648-666(Oct 1982).

Cross-section uncertainty covariance matrices are generated and used with sensitivity coefficients to obtain estimates for the uncertainties in design parameters of a particular class of fission-fusion hybrid reactors, the SOLASE-H design. The analysis shows that the uncertainty in the ^{233}U production ratio is about 4% and is due mostly to errors associated with the lead cross sections. Reducing the uncertainty in the Pb(n,2n'), Pb(n,3n'), and the Pb(n,nonelastic) cross sections, particularly in the energy range of 9 to 20 MeV, will significantly reduce this uncertainty. Improving the Th(n,γ) cross section in the energy range of 0.35 to 3.35 keV can lead to a 40% reduction in the uncertainty in the ^{233}U-breeding ratio. It is found that more accurate evaluation of the Pb(n,nonelastic) cross section in the energy range of 0.73 to 14 MeV can reduce the uncertainty in tritium breeding from ^{6}Li by about 25%. The uncertainty of only 1% found in the tritium-breeding ratio from ^{7}Li indicates that present nuclear data uncertainties are adequately small. Uncertainty in displacements per atom in Zircaloy-2 cladding due to uncertainties in the Pb(n,inelastic) cross section is small. The analysis reveals the importance of reducing uncertainties in the Th(n,fission) cross sections to minimize the uncertainty in the heating rate from nuclear reactions. It is found that uncertainties in the $^{6}Li(n,\alpha)$ cross section are acceptable in calculating the various nuclear parameters of the SOLASE-H design.

5614 **Cyclic temperature and thermal stress fluctuations in fusion reactors.** Bohachevsky, I.O.; Kostoff, R. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Nuclear Technology/Fusion;* 2: No. 4, 687-699(Oct 1982).

Cyclic thermal loads and stresses in two critical components of fusion reactors, including fusion-fission hybrids, are modeled and calculated. The two critical components are the solid wall adjacent to the fusion plasma ("first wall") and the fissile fuel elements in the high-power density region of the blanket. These two components exemplify two limiting cases of thermal loading: The first-wall loads are generated by predominantly shallow energy deposition that may be approximated with a flux across the surface and the fuel elements loads are generated by volumetric heating. Two approaches are used to solve the heat conduction equation and to calculate the resulting stresses in terms of system parameters. The first is expansion into Fourier series and determination of periodic solutions; the second is analysis and superposition of single-pulse responses weighted with appropriate time delay and decay factors. Approximate closed-form expression for temperature excursions and thermal stresses are derived; these expressions may be evaluated conveniently and rapidly for comparison of different systems. The results provide a quantitative basis for trade-off studies and comparative assessments of different fusion reactor systems.

5615 **The design of the poloidal divertor experiment tokamak wall armor and inner limiter system.** Kugel, H.W.; Ulrickson, M. (Princeton University, Princeton Plasma Physics Laboratory, P.O. Box 451, Princeton, New Jersey 08544). *Nuclear Technology/Fusion;* 2: No. 4, 712-722(Oct 1982). Contract AC02-76CH03073.

The inner wall protective plates for the Poloidal Divertor Experiment Tokamak are designed to absorb 8 MW of neutral deuterium beam power at maximum power densities of 3 kW/cm² for pulse lengths of 0.5 s. Preliminary studies indicate that the design could survive several pulses of l-s duration. The design consists of a tile and mounting plate structure. The mounting plates are water cooled to allow short duty cycles and beam calorimetry. The temperature and flow of the coolant are measured to obtain the injected power. A thermocouple array on the tiles provides beam position and power density profiles. Several material combinations for the tiles were subjected to thermal tests using both electron and neutral beams, and titanium-carbidecoated graphite was selected as the tile material. The heat transfer coefficient of the tile backing plate structure was measured to determine the maximum pulse rate allowable. The design of the armor system allows the structure to be used as a neutral beam power diagnostic and as an inner plasma limiter. The electrical and cooling systems external to the vacuum vessel are discussed.

5616 **Occupational radiation exposures at a fusion power station.** Easterly, C.E. (Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, Tennessee 37830). *Nuclear Technology/Fusion;* 2: No. 4, 723-739(Oct 1982). Contract W-7405-ENG-26.

Fusion power stations utilizing the deuteriumtritium reaction may not result in significantly different occupational radiation exposures than are obtained currently at light water reactor (LWR) stations, even with modest advances in remote control technology. The primary reasons for this observation follow. Mobile activation products will be generated at about twice the rate of LWRs. A significantly greater amount of work in elevated radiation zones is associated with repair and maintenance of not only the blanket and first wall, but also the large number of diagnostic and auxiliary systems required for fusion that are not required for fission. The prevalence of tritium throughout most of the reactor complex and the fuels and materials cycle. Very few specific numbers can be estimated with reasonable certainty at present; however, the general picture of occupational hazards at fusion reactors is slowly taking a rough form.

5617 **Constrained ripple optimization of tokamak bundle divertors.** Hively, L.M.; Dory, R.A.; Fowler, R.H.; Lynch, V.E.; Lyon, J.F.; Peng, M.; Rome, J.A. (General Electric Company at Oak Ridge, National Laboratory Fusion Energy Design Center, Oak Ridge, Tennessee 37830). *Nuclear Technology/Fusion;* 2: No. 3, 372-391(Jul 1982).

Magnetic field ripple from a tokamak bundle divertor is localized to a small toroidal sector and must be treated differently from the usual (distributed) toroidal field (TF) coil ripple. Generally, in a tokamak with an unoptimized divertor design, all of the banana-trapped fast ions are quickly lost due to banana drift diffusion or to trapping between the 1/R variation in /B/ is identical to B and local field maxima due to the divertor. Studying the full three-dimensional shape of the B-surfaces allows quick evaluation of many inferior designs. For designs that eliminate any large maxima in B, low on-axis ripple is a good indicator of avoiding deleterious effects due to the divertor. However, this must be achieved while satisfying many engineering constraints. A computer code has been written to optimize automatically on-axis ripple subject to these constraints, while varying up to nine design parameters. Optimum configurations have low on-axis ripple ($<0.2\%$) so that, now, most banana-trapped fast ions are confined. Only those ions with banana tips near the outside region (//OMICRON// $\leqq$45 deg) are lost. However, because finite-sized TF coils have not been used in this study, the flux bundle is not expanded.

5618 **Design of the PRETEXT tokamak.** Benesch, J.F.; Bengtson, R.D.; Cardwell, G.L.; Eckstrand, S.A.; Gandy, R.F.; Wildi, P. (Univ of Texas at Austin, Fusion Research Center, Austin, Texas). *Nuclear Technology/Fusion;* 2: No. 3, 398-409(Jul 1982).

The PRETEXT tokamak was designed to investigate the initial stages of a tokamak discharge. The machine has a major radius of 53 cm, limiter radius of 15 cm, and a toroidal field (TF) of 8 kG. Plasma currents of 40 to 60 kA with durations of 40 to 70 ms are typical. Chord average density is of the order of 10^{13} cm^{-3}, the electron temperature T /SUB e/ (0) about 300 eV, and the effective charge Z /SUB eff/ about 3. The ohmic-heating (OH) transformer is unique among operating machines, having an iron core and air return. Combinations of mechanical and electronic switches in the OH and TF power supplies provide good reliability at low jitter and low cost. The design and construction of the PRETEXT tokamak are discussed in enough detail to give a feeling for the compromises that must be made and the problems that will be encountered in the building of any controlled thermonuclear reactor device.

5619 **Source-to-incident flux relation for a tokamak fusion test reactor blanket module.** Imel, G.R. (EG & G Idaho, Inc., P.O. Box 1625, Idaho Falls, Idaho 83415). *Nuclear Technology/Fusion;* 2: No. 3, 426-429(Jul 1982). Contract AC07-76ID01570.

The source-to-incident 14-MeV flux relation for a blanket module on the Tokamak Fusion Test Reactor is derived. It is shown that assumptions can be made that allow an analytical expression to be derived, using point kernel methods. In addition, the effect of a nonuniform source distribution is derived, again by relatively simple point kernel methods. It is thought that the methodology developed is valid for a variety of blanket modules on tokamak reactors.

5620 **Time-dependent neutronics analysis for the HIBALL heavy ion beam fusion reactor.** Sawan, M.E.; Kulcinski, G.L.; Moses, G.A. (University of Wisconsin, Fusion Engineering Program, Nuclear Engineering Department, Madison, Wisconsin). *Nuclear Technology/Fusion;* 2: No. 2, 215-223(Apr 1982).

Time-dependent neutronics analysis for the ferritic steel first wall of the HIBALL heavy ion beam fusion reactor conceptual design is presented. Neutron target interactions that lead to spectrum softening and neutron multiplication are accounted for. The time-of-flight (TOF) spread of neutrons within each energy group is considered. Neutron slowing down in the INPORT first-wall protection system, which is similar to the HYLIFE concept, is found to significantly affect the time over which the damage occurs in the first wall. In the case of an unprotected wall, the time spread is determined primarily by the TOF spread. The INPORT concept is found to significantly reduce both average and peak instantaneous rates of displacements per atom, helium production, and energy deposition in the first wall.

5621 **A critical assessment of the effects of pulsed irradiation on the microstructure, swelling, and creep of materials.** Ghoniem, N.M.; Kulcinski, G.L. (University of California at Los Angeles, School of Engineering and Applied Science, Los Angeles, California). *Nuclear Technology/Fusion;* 2: No. 2, 165-198(Apr 1982).

The effects of pulsed irradiation on the response of materials are reviewed in terms of the basic principles behind the experimental and theoretical efforts in this area. A general background on the phenomena associated with pulsed irradiation in a fusion reactor environment is outlined. It is shown that the systems most likely to have significant dynamic response to pulsed irradiation will be the inertial confinement fusion reactors (ICFRs), and to a lesser degree, the near-term tokamak fusion reactors. A brief description of the magnitudes of radiation damage and the time scales over which damage occurs is given for various fusion reactor concepts. This sets the boundary conditions that need to be considered in analyzing radiation effects in pulsed fusion systems. The work on the primary damage state is reviewed, analyzing the effects of neutrons and ions on the instantaneous damage state of ICFRs. Since the energy deposition manifests itself in the form of damage and heat, the temperature and stress waves accompanying damage in ICFR walls are discussed. The state of knowledge on the microstructure evolution during pulsed irradiation is outlined in detail giving the theoretical principles and experimental observations. Finally, the relationships between the evolving microstructure and properties such as swelling, solute segregation, and irradiation creep in a pulsed irradiation environment are investigated.

5622 **Modeling of lithium fires.** Tillack, M.S.; Kazimi, M.S. (Massachusetts Institute of Technology, Dept of Nuclear Engineering, Cambridge, MA). *Nuclear Technology/Fusion;* 2: No. 2, 233-245(Apr 1982).

A computer code, LITFIRE, has been written to simulate the effects of lithium fires in fusion reactor containments. Development of the models in the code is discussed. Results of a study based on small-scale tests of lithium fires indicate that the code is capable of reasonable predictions of the temperature of the lithium pool and the atmosphere. However, the effects of simultaneous reactions with oxygen and nitrogen are the major source of uncertainty.

5623 **Catalyzed deuterium-deuterium and deuterium-tritium fusion blankets for high temperature process heat production.** Ragheb, M.M.H.; Salimi, B. (Univ. of Illinois, Nuclear Energy Program, Urbana, IL). *Nuclear Technology/Fusion;* 2: No. 1, 55-72(Jan 1982).

Tritiumless blanket designs, associated with a catalyzed deuterium-deuterium (D-D) fusion cycle and using a single high temperature solid pebble or falling bed zone, for process heat production, are proposed. Neutronics and photonics calculations, using the Monte Carlo method, show that an about 90% heat deposition fraction is possible in the high temperature zone, compared to a 30 to 40% fraction if a deuterium-tritium (D-T) fusion cycle is used with separate breeding and heat deposition zones. Such a design is intended primarily for synthetic fuels manufacture through hydrogen production using high temperature water electrolysis. A system analysis involving plant energy balances and accounting for the different fusion energy partitions into neutrons and charged particles showed that plasma amplification factors in the range of 2 are needed. In terms of maximization of process heat and electricity production, and the maximization of the ratio of high temperature process heat to electricity, the catalyzed D-D system outperforms the D-T one by about 20%. The concept is thought competitive to the lithium boiler concept for such applications, with the added potential advantages of lower tritium inventories in the plasma, reduced lithium pumping (in the case of magnetic confinement) and safety problems, less radiation damage at the first wall, and minimized risks of radioactive product contamination by tritium.

5624 **Neutronic calculations for the conceptual design of an in-reactor solid breeder experiment, triO-01.** Childs, R.L.; Gabriel, T.A.; Lillie, R.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee). *Nuclear Technology/Fusion;* 2: No. 1, 73-79(Jan 1982).

Neutronics calculations have been performed to obtain tritium production and heat generation rates for the irradiation of solid tritium breeding materials in the Oak Ridge Research Reactor. Two breeder materials, Li_2O and $LiAlO_2$, were considered. Burnup calculations were performed to estimate the amount of ^6Li present as a function of time. Both natural lithium and lithium depleted in ^6Li were considered.

5625 **The effect of quadrupole fields on particle confinement in a field-reversed mirror.** McColl, D.B.; Berk, H.L.; Hammer, J.; Morse, E.C. (Univ. of California, Dept. of Nuclear Engineering, Berkeley, CA). *Nuclear Technology/Fusion;* 2: No. 2, 80-84(Jan 1982).

A particle simulation code has been modified to simulate particle loss caused by quadrupole magnetic fields on a field-reversed mirror plasma device. Since analytic fields are chosen for the equilibrium, the numerical algorithm is highly accurate for long-time integrations of particle orbits. The resultant particle loss due to the quadrupole fields can be competitive with collisional loss in the device.

5626 **Ideal and resistive magnetohydrodynamic stable startup and burn for the reversed-field pinch reactor.** Nebel, R.A.; Miley, G.M.; Moses, R.W. (Los Alamos National Laboratory, Los Alamos, NM). *Nuclear Technology/Fusion;* 2: No. 1, 85-90(Jan 1982). Contract W-7405-ENG-36.

A crucial question for the feasibility of high-beta ohmically heated devices, such as the reversed field pinch (RFP) and the Spheromak, is whether such devices can be formed with a modest amount of field dissipation and energy loss. By means of a convective startup technique, a low-loss formation and burn scenario for the RFP reactor, which maintains effective stability to ideal and resistive magnetohydrodynamic modes, is simulated. Results indicate small aspect ratio machines have the best possibilities for stable startup.

5627 **Oscillating limiter concepts.** Ming Lun Xue; Tien-Fang Yang. (Massachusetts Institute of Technology, Plasma Fusion Center, Cambridge, Massachusetts 02139). *Nuclear Technology/Fusion;* 2: No. 1, 91-95(Jan 1982).

An oscillating multiple limiter concept for tokamak fusion reactors has been conceived. The limiters consist of half-circle or

short arc segments in the poloidal direction. They are oscillated locally in the scrape-off layer. Alternately, each limiter will be in contact with the plasma for 50 ms or less at an interval of 0.5 s. It is shown that the limiter can be subjected to a transient heat load as high as 10 kW/cm² during the exposure time and can be cooled by water or helium in 0.5 s during the off-time. Only a few centimetres of movement is needed. A simple driving mechanism is also proposed.

5628 **Hybrid bundle divertor design.** Bateman, G. (Georgia Institute of Technology, School of Nuclear Engineering, Atlanta, GA). *Nuclear Technology/Fusion;* **2**: No. 1, 96-104(Jan 1982).

A hybrid bundle divertor design is presented that produces <0.3% magnetic ripple at the center of the plasma while providing adequate space for the coil shielding and structure for a tokamak fusion test reactor similar to the International Tokamak Reactor and the Engineering Test Facility (with R = 5 m, B = 5 T, and a /SUB wall/ = 1.5 m, in particular). This hybrid divertor consists of a set of quadrupole "wing" coils running tangent to the tokamak plasma on either side of a bundle divertor. The wing coils by themselves pull the edge of the plasma out 1.5 m and spread the thickness of the scrape-off layer from 0.1 to 0.7 m at the midplane. The clear aperture of the bundle divertor throat is 1.0 m high and 1.8 m wide. For maintenance or replacement, the hybrid divertor can be disassembled into three parts, with the bundle divertor part pulling straight out between toroidal field coils and the wing coils then sliding out through the same opening.

5629 **Response of liquid lithium layers to neutron and x-ray pulses.** Bohackevsky, Ihor O. (University of California, Los Alamos National Laboratory, Group S-5, MS 529, P.O. Box 1663, Los Alamos, New Mexico). *Nuclear Technology/Fusion;* **2**: No. 1, 110-119(Jan 1982).

Many inertial confinement fusion reactors will employ liquid lithium to breed tritium, to remove heat from reactor vessels, and to protect the interior walls of the vessel. Heat loads on the liquid lithium will consist of intense pulses that are short in comparison to hydrodynamic and thermal relaxation times and therefore will generate pressure pulses and/or pressure waves. The generation process is investigated analytically and numerically. Analytic solutions are derived for liquid blankets with thicknesses comparable to the neutron energy deposition depth contained between two structural shells and for free surface layers with thicknesses much smaller than the depth of neutron energy deposition. Results indicate that the amplitudes of the neutron-generated pressure waves are comparable to the mean pressure rise that would be obtained if the energy were deposited so slowly and uniformly that the waves did not develop. Pulses in lithium layers, which are initially at the vapor pressure. Results indicate that rapid heating occurs at constant specific volume (isochorically) and therefore results in a sharp and intense pressure rise. However, the resulting pressure wave dissipates after propagating only a few millimetres through the layer if the lithium contains any fraction of the vapor phase.

5630 **The impact of engineering constraints on the feasibility of advanced fuel fusion reactors.** Roth, J.R. (University of Tennessee, Dept. of Electrical Engineering, Knoxville, TN). *Nuclear Technology/Fusion;* **2**: No. 1, 29-42(1982).

The consequences are assessed of a common set of engineering constraints on the characteristics of fusion reactors that employ deuterium-tritium (D-T), advanced, and exotic fusion fuel cycles. A set of uniform assumptions is made regarding blanket costs, wall loading limits, fusion power density limits, radiofrequency technologies, etc. From these common constraints, the regimes of ion number density, ion kinetic temperature, and plasma stability index β, which lead to attractive fusion reactors, are found. It is demonstrated that if tokamaks are restricted to values of $\beta < 0.05$, no fuel cycle other than D-T is compatible with currently accepted engineering constraints. The catalyzed deuterium-deuterium and the D-^{3}He reactions are attractive for values of $\beta >$ about0.20. It is found that the charged particle or "neutronfree" reactions such as p-^{6}Li, even if ignitible, are inconsistent with engineering constraints, even at $\beta = 1.0$, because of their low reactivity. As expected, the D-T reaction allows the widest range of operating parameters because of its high reactivity. However, it can be used only with difficulty at high values of β because of wall loading limitations. Finally, the limitations imposed by electron cyclotron resonance heating (ECRH) of the plasma are examined. It is found that the cutoff density implied by ECRH (above which radiation is reflected from the plasma) places a serious additional constraint on the accessible operating regime of some advanced fuel fusion reactors.

5631 **The Texas Experimental Tokamak (TEXT) facility.** Gentle, K.W. (University of Texas at Austin, Fusion Research Center, Austin, Texas). *Nuclear Technology/Fusion;* **1**: No. 4, 479-485(Oct 1981).

The Texas Experimental Tokamak is a mediumscale tokamak operated as a national user facility. Now in operation, it provides a plasma with a 1-m major radius, 28-cm minor radius, and 400-kA nominal plasma current at up to 3-T toroidal field for pulse lengths of 300 to 500 ms. The facility includes all standard tokamak diagnostics and an integrated data system that makes all data available after each shot, as often as once every 2 min. The design is generally conventional and conservative; the vacuum vessel provides numerous large-aperture radial and vertical ports for complete views of the plasma.

5632 **U.S. conceptual design contribution to the INTOR phase 1 workshop.** Stacey, W.M. Jr.; Abdou, M.A.; Schmidt, J.A.; Shannon, T.E. (Georgia Institute of Technology, Atlanta, Georgia). *Nuclear Technology/Fusion;* **1**: No. 4, 486-532(Oct 1981).

A conceptual design of a first-generation tokamak engineering test reactor is presented. The objectives, testing mission, and role in the fusion program of such a device are discussed. The physics, nuclear, and engineering design are described, and the projected operational schedule is outlined. An estimate of the cost and design/construction schedule is presented.

5633 **Power density flattening in fusion-fission hybrid reactors.** Erickson, K.; McCormick, N.J.; Woodruff, G. (Univ. of Washington, Dept. of Nuclear Engineering, Seattle, Washington). *Nuclear Technology/Fusion;* **1**: No. 4, 533-541(Oct 1981).

The feasibility of spatial and temporal power density flattening in fusion-fission hybrid reactors was investigated by varying the concentration of ^{239}Pu within a set of zones in the fission region and by examining two different fuel management schemes. Blanket designs with no ^{239}Pu typically had a spatial maximum-to-average power density ratio of about 2.5, but this value was reduced to between 1.26 and 1.67, depending on the design and fuel management scheme selected. Unfortunately, however, significant impact occurs only with relatively high fissile concentrations, with the outer zones approaching equilibrium values. Thus, either an impractically large fissile inventory for startup or long operating histories would be required.

5634 **Plasma behavior in magnetically protected inertial confinement fusion reactor cavities.** Bohachevsky, I.O.; Goldstein, J.C. (Los Alamos National Laboratory, Los Alamos, NM). *Nuclear Technology/Fusion;* **1**: No. 3, 390-401(Jul 1981).

(Investigations of the feasibility of commercial inertial confinement fusion (ICF) reactors have led to studies of a variety of plasma regimes and behaviors. Presented are: a general discussion of phenomena inside ICF reactor vessels; parameter ranges of interest in practical applications; mathematical description of a new plasma model; and representative results with discussions of their utility.) The plasma model developed for the study of phenomena inside ICF reactor cavities with magnetically protected walls is composed of three constituents: ionized atoms in local thermodynamic equilibrium that are initially distributed uniformly throughout the region of interest and can be represented as a fluid; energetic ions whose range in the fluid constituent is equal to or greater than characteristic dimensions of the reactor vessel; and electrons. These constituents interact through electrodynamic and collisonal forces and through ionization and/or recombination processes. The finite difference equations describing these interactions are solved numerically; the solutions represent time evolutions of conditions inside cylindrical reactor cavities following the production of ener-

getic ions during the compression and burn of the deuterium-tritium fuel inside a small pellet. Debris plasma expansion occurs through an ionized low-density background fluid with an imbedded externally generated magnetic field. Results indicate that the background fluid has little effect on ion trajectories before the pressure waves reflect from the cavity walls; however, the ions impart such a high velocity to the background fluid that in spite of large energy deposition, the temperature and density in the region interior to the expanding ions decrease to very low values.

5635 **An overview of inertial fusion reactor design.** Monsler, M.J.; Cook, D.L.; Frank, T.G.; Hovingh, J.; Moses, G.A. (Univ. of California, Lawrence Livermore National Laboratory, Livermore, CA). *Nuclear Technology/Fusion;* **1**: No. 3, 302-358(Jul 1981).

Recent progress in the conceptual design of inertial fusion reaction chambers and power plants is reviewed. A discussion of expected operating parameters and a brief historical perspective are provided to organize the rich array of chamber and driver concepts. The technical feasibility of several reaction chamber concepts is discussed, along with technical issues that require future analysis, experiment, and development. Where these chambers have been integrated into a power plant design, the characteristics are described. Finally, requirements on the future development of inertial fusion reactor technology are discussed.

5636 **Technology requirements for commercial applications of inertial confinement fusion.** Frank, T.G.; Rossi, C.E. (Los Alamos National Laboratory, Los Alamos, NM). *Nuclear Technology/Fusion;* **1**: No. 3, 359-376(Jul 1981).

Current inertial confinement fusion (ICF) research is directed primarily at physics experiments intended to provide confidence in the scientific feasibility of the basic concept. In conjunction with these experiments, a variety of laser and particle beam drivers having potential for eventual use in fusion power plants is being developed. Expectations are that the scientific feasibility of ICF will be demonstrated in the latter part of the 1980s. At that time, the emphasis of the program will shift to engineering, economic, environmental, and licensing issues with the necessary technology development effort continuing into the early part of the next century. This paper discusses the technology requirements for the successive phases of engineering development leading to commercial application of ICF. The engineering areas requiring significant effort for ICF application include high average power driver development; pulsed high-energy power supply development; reactor cavity and heat transport system design; tritium extraction and control; commercial pellet development; pellet injection, tracking, and targeting systems design; materials radiation, fatigue, and corrosion behavior; and reactor plant systems integration and demonstration.

5637 **Cavity gas analysis for light-ion-beam fusion reactors.** Peterson, R.R.; Cooper, G.W.; Moses, G.A. (University of Wisconsin, Fusion Engineering Program, Nuclear Engineering Department, Madison, Wisconsin). *Nuclear Technology/Fusion;* **1**: No. 3, 377-389(Jul 1981).

The criteria governing the choice of cavity gas for light-ion-beam fusion reactors have been investigated. Possible mechanisms of laser initiation of plasma discharge channels and the effects of cavity gas choice on one of the most promising mechanisms are discussed. The shock overpressure and the thermal heat flux experienced by the first wall are studied for a variety of cavity gases. Small amounts of alkali metal vapors are found to be useful in both limiting the thermal heat flux and initiating the plasma channels. A 50-Torr argon cavity gas with a 0.2% sodium impurity has been found to allow both efficient laser channel initiation and first-wall survivability.

5638 **Cryotrapping vacuum pumping system design for a helium neutral beam injector.** Hoffman, M.A.; Blum, A.S. (Lawrence Livermore National Laboratory, Livermore, CA). *Nuclear Technology/Fusion;* **1**: No. 2, 275-284(Apr 1981).

The conceptual design of a vacuum pumping system to handle a large gas flow on the order of 2.31 Pa X m^3/s (17.3 standard (std) Torr X l/s) of helium gas in the pressure range from about 3.1 X 10^{-2} down to 4.0 X 10^{-4} Pa (2.3 X 10^{-4} down to 3 X 10^{-6} Torr) is described. The neutral helium gas originates partly as leakage from the plasma ion source and partly as additional gas required in the neutralizer duct of the neutral beam injector. The vacuum pumping design is based on the recently demonstrated process of cryotrapping the helium in a frost layer of argon formed by spraying the argon onto a liquid-heliumcooled cryopanel surface. About 10.6 m^2 of cryopanel area in the ducts and chambers of the injector is required for an allowed frost thickness of 1 mm. The design is based on preliminary experimental results that indicated that about 15 atoms of argon were needed to pump and cryotrap each helium atom, and that the specific pumping speed of the fully baffled cryopanels would be about 31.5 std m^3/m^2 X s (3.15 std X l/cm^2 X s). Preliminary estimates of costs indicate that this vacuum system can cost as much as 74% of the entire neutral beam injector and that the LHe cryo-refrigerator alone can cost 24% of the total direct cost. The design points up the problem areas of cryotrapping helium and the need for clever new design concepts and improved performance to reduce costs.

5639 **Materials technology for fusion: current status and future requirements.** Gold, R.E.; Bloom, E.E.; Clinard, F.W. Jr.; Smith, D.L.; Stevenson, R.D.; Wolfer, W.G. (Westinghouse Fusion Power Systems, Pittsburgh, PA). *Nuclear Technology/Fusion;* **1**: No. 2, 169-237(Apr 1981).

An overview is presented of the general status of materials research and development activities related to the needs of controlled thermonuclear fusion reactors. Emphasis is placed on materials research and applications pertinent to magnetic confinement reactor concepts vis-a-vis inertial confinement reactor requirements; this reflects the greater maturity of the magnetic confinement technology programs. The research efforts associated with materials development for first-wall applications are given special attention; in addition, the research and general status of programs aimed at nonfirst-wall or nonstructural fusion reactor materials requirements are also reviewed.

5640 **A study of the tritium handling systems in magnetic and inertial confinement fusion reactors with and without tritium breeding.** Ortman, M.S.; Abdel-Khalik, S.I.; Larsen, E.M. (University of Wisconsin-Madison, Department of Chemistry and Fusion Engineering Program, Madison, Wisconsin 53706). *Nuclear Technology/Fusion;* **1**: No. 2, 255-274(Apr 1981).

The tritium pathways and handling systems in 20 different conceptual magnetic and inertial confinement fusion reactor designs have been examined and compared. The primary objectives of this investigation were: to determine the effects, if any, of the plasma confinement scheme, reactor fueling method, and first-wall protection scheme on the design and relative complexity of the tritium handling systems; and to quantify the advantages and disadvantages of removing the tritium breeding function from the reactor. It is concluded that, from a tritium handling viewpoint, inertial confinement reactors with either gasprotected or magnetically protected first walls, pellet-fueled tandem mirrors, and reversed-field pinch reactors are preferred. On the other hand, the tritium handling problem is at a maximum in laser-driven reactors with either a wetted wall or lithium fall protection, tokamaks, standard mirrors, and fast-liner reactors. Theta pinches and neutral-beam-fueled tandem mirrors belong to an intermediate category. It is also concluded that transfer of the tritium breeding function from the reactor blanket to an external source does not result in significant benefits.

5641 **Stability of the lithium "WATERFALL" first wall protection concept for inertial confinement fusion reactors.** Esser, P.D.; Abel-Khalik, S.I.; Paul, D.D. (University of Wisconsin-Madison, Nuclear Engineering Department, Madison, Wisconsin 53706). *Nuclear Technology/Fusion;* **1**: No. 2, 285-294(Apr 1981). Contract W-7405-ENG-48.

Uncertainties regarding the feasibility of using an annular "waterfall" of liquid lithium to protect the first wall in inertial confinement fusion reactor cavities have prompted a theoretical investigation of annular jet stability. Infinitesimal perturbation techniques are applied to an idealized model of the jet with disturbances acting upon either or both of the free surfaces. Dispersion relations are de-

rived that predict the range of disturbance frequencies leading to instability, as well as the perturbation growth rates and jet breakup length. The results are extended to turbulent annular jets and are evaluated for the lithium waterfall design. It is concluded that inherent instabilities due to turbulent fluctuations will not cause the jet to break up over distances comparable to the height of the reactor cavity.

5642 **Performance and economics analysis of several laser fusion breeder fueled electricity generation systems.** Berwald, D.H.; Maniscalco, J.A. (TRW Inc., Redondo Beach, CA). *Nuclear Technology/Fusion;* **1**: No. 1, 137-159(Jan 1981).

(An analysis of the potential performance and economic characteristics of several laser fusion breeder reactor (i.e., fusion-fission hybrid) fueled electricity generation systems has been performed. Fusion breeders resulting from several recent conceptual design studies are considered. These are distinguished from one another by the utilization of one of several generic breeder blanket options including a uranium fast fission blanket, a thorium fast fission blanket, a uranium-thorium fast fission blanket, and a thorium-suppressed fission blanket (first time introduced). On the fission side of the system, light water reactors (LWRs), which primarily burn ^{233}U (but also some plutonium), are considered.) The fission fuel cycle characteristics and relative proliferation resistance of the various symbiotic electricity generation systems are examined. The results of the economic analysis indicate that systems utilizing LWRs and any of the four breeder blanket concepts can produce electricity for about25 to 35% above the cost of electricity produced by a new LWR operating on the current once-through fuel cycle. The laser fusion breeders are predicted to become competitive (as an LWR fuel source) with conventional mined sources of U_3O_8 when the price of U_3O_8 reaches about $300/kg (1980 dollars). The results suggest that fusion breeders could supply most or all of our fissile fuel makeup requirements within about20 yr after commercial introduction (possibly in 2010) and have nearly unlimited capabilities to support a growing system of LWRs or advanced converter reactors.

5643 **Trends and developments in magnetic confinement fusion reactor concepts.** Baker, C.C.; Carlson, G.A.; Krakowski, R.A. (Argonne National Laboratory, Argonne, Illinois). *Nuclear Technology/Fusion;* **1**: No. 1, 5-78(Jan 1981).

An overview is presented of recent design trends and developments in reactor concepts for magnetic confinement fusion. The paper emphasizes the engineering and technology considerations of commercial fusion reactor concepts and reactors that operate on the deuterium/tritium/ lithium fuel cycle. Recent developments in tokamak, mirror, and Elmo Bumpy Torus reactor concepts are described, as well as a survey of recent developments on a wide variety of alternate magnetic fusion reactor concepts (within the last two to three years).

5644 **Contribution of activation products to fusion accident risk: part 1. A preliminary investigation.** Holdren, J.P. (University of California, Berkeley Energy and Resources Program, Berkeley, California 94720). *Nuclear Technology/Fusion;* **1**: No. 1, 79-89(Jan 1981).

Release of neutron-activation products in severe hypothetical fusion-reactor accidents may constitute a larger health hazard than that of the tritium released at the same time. Significant escape of activation products could result from lithium fires hot enough to melt and partly vaporize activated first-wall materials, or from other accident sequences that bring air into contact with activated structure hot enough to cause the formation of volatile metal oxides. Analysis of three combinations of structural materials and severe accident scenarios has been undertaken for an early conceptual tokamak reactor, using a simple consequence model based on that of the Nuclear Regulatory Commission's Reactor Safety Study (the Rasmussen report) to determine conceivable radiation doses near the plant boundary. No attempt was made to estimate probabilities for such severe events. In the cases of stainless-steel and molybdenum structures subject to massive lithium fires, the boundary doses far exceed those that would be produced by release of the entire plant inventory of tritium and are comparable to the doses similarly calculated for "worst case" light water reactor accidents. The case of niobium fusion reactor structure is more favorable. These results, based on an early fusion-reactor design not optimized with respect to safety characteristics, may well portray a worst case picture of fusion accident consequences. They suggest, however, that the large potential safety advantages of fusion compared to fission are not necessarily inherent for all designs and choices of materials, and they motivate attention to the several available strategies for greatly reducing the potential for activation-product release from fusion reactors.

5645 **Preliminary skyshine calculations for the Poloidal Diverter Tokamak Experiment.** Nigg, D.W.; Wheeler, F.J. (EG and G Idaho Inc., Idaho Falls, Idaho). *Nuclear Technology/Fusion;* **1**: No. 1, 90-98(Jan 1981).

The Poloidal Diverter Experiment (PDX) facility at Princeton University is the first operating tokamak to require substantial radiation shielding. A calculational model has been developed to estimate the radiation dose in the PDX control room and at the site boundary due to the skyshine effect. An efficient one-dimensional method is used to compute the neutron and capture gamma leakage currents at the top surface of the PDX roof shield. This method employs an S /SUB n/ calculation in slab geometry and, for the PDX, is superior to spherical models found in the literature. If certain conditions are met, the slab model provides the exact probability of leakage out the top surface of the roof for fusion source neutrons and for capture gamma rays produced in the PDX floor and roof shield. The model also provides the correct neutron and capture gamma leakage current spectra and angular distributions, averaged over the top roof shield surface. For the PDX, this method is nearly as accurate as multidimensional techniques for computing the roof leakage and is much less costly. The actual neutron skyshine dose is computed using a Monte Carlo model with the neutron source at the roof surface obtained from the slab S /SUB n/ calculation. The capture gamma dose is computed using a simple point-kernel single-scatter method.

5646 **Neutronics shielding analysis of the last mirror-beam duct system for a laser fusion power reactor.** Ragheb, M.M.H.; Klein, A.C.; Maynard, C.W. (University of Illinois, Nuclear Engineering Program, Urbana-Champaign, Illinois). *Nuclear Technology/Fusion;* **1**: No. 1, 99-119(Jan 1981).

Three-dimensional Monte Carlo neutronics calculations for the last mirror-beam duct system for a laser-driven fusion power reactor conceptual design, where a three-section duct with focusing mirrors and right angle bends for the last two beam reflections is modeled. The estimate of neutron leakage flux after the second beam reflection is on the order of 10^{14} n/(m^2 X s). Even though less in magnitude than the flux at the end point of neutral beam injectors in tokamak designs, reported in the range of 10^{17} n/(m^2 X s), this still leads to a neutron dose rate of 10^6 rem/h after the second beam bend. Since space is not at a premium as in the case of magnet shields for magnetic confinement systems, minimum-cost lead mortar or concrete can be used as shielding materials instead of other minimum thickness costly materials. An energy leakage rate of 4.6 MW of 14-MeV neutrons per beam precludes the use of concrete behind the last mirror, suggesting the use of a secondary blanket composed of a lead acetate solution with immersed Boral (Al + B_4C) sheets. Boral as a penetration shielding material is found to reduce the thermal group flux around the penetration by two to three orders of magnitude, compared to aluminum, and is recommended as a duct lining material for both inertial and magnetic fusion systems. Neutron heating rates and radiation damage parameters for the duct liner compare to those at the front face of the last mirror and first wall, and will require similar elaborate thermalhydraulic and mechanical designs.

5647 **A system for handling diverter ion and energy flux based on a lithium droplet cloud.** Wells, W.M. (Oak Ridge National Laboratory, Oak Ridge, Tennessee). *Nuclear Technology/Fusion;* **1**: No. 1, 120-127(Jan 1981).

A novel ion and energy absorption system is proposed for use with tokamak diverters. The key to its feasibility is to accelerate the liquid-lithium working material outside the magnetic field, then have it pass through the magnetic field as free droplets. This avoids any significant magnetohydrodynamic effect on the liquid-

metal motion. Thermal, fluid flow, and vacuum parameters are evaluated, and it is indicated that they have considerable flexibility.

5648 **An economics method for symbiotic fusion-fission electricity generation systems.** Berwald, D.H.; Maniscalco, J.A. (TRW Inc., Redondo Beach, CA). *Nuclear Technology/ Fusion;* **1**: No. 1, 128-137(Jan 1981).

A self-consistent analytical methodology for evaluating the economic incentives for symbiotic electricity generation systems that consist of fusion breeder reactors and supported fission converter reactors is developed. This methodology employs a discounted cash flow analysis of breeder and converter direct operating costs and indirect capital costs, as well as a novel treatment of fissile inventory charges. Three figures of merit are emphasized: the levelized cost of electricity generated by the symbiotic system; the levelized cost of fuel exchanged by the breeder and converter reactors in the system; and the equivalent cost of fuel to produce the same levelized electricity cost in a alternatively fueled converter reactor. A fission converter operating on the current once-through fuel cycle is a special case of the above. The method is equally applicable to symbiotic systems that utilize spallation accelerator breeder reactors.

99 GENERAL AND MISCELLANEOUS

9901 Management

5649 **(DOE/MA—0008/10) Department of Energy Audit Report Tracking System (DARTS). Quarterly management report as of September 30, 1983.** (USDOE Assistant Secretary for Management and Administration, Washington, DC. Office of the Controller). Nov 1983. 83p. NTIS, PC A05/MF A01. Order Number DE84002605.

Information is provided by this report to DOE management on the status of corrective actions on audit recommendations contained in reports on audits of DOE activities, programs and contracts. It is based on data accumulated in accordance with DOE Order 2300.1A, which established a DOE Audit Report Tracking System (DARTS). The DARTS activity for the fourth quarter of fiscal year 1983 is summarized. The statistics presented on GAO and Headquarters IG issued audit reports pertaining to those processed by DOE Headquarters offices. Two such IG reports for which field offices had prime responsibility for audit followup activity are included in the field office statistics. The activity of the Office of Procurement and Assistance Management and the field offices pertained primarily to reports on audits of contracts and grants. Those reports were issued by various auditing organizations, including the Defense Contract Audit Agency, Government Owned-Contractor Operated activities, states, public accountants, and field office auditors. The 398 reports open at the end of the quarter were 30 less than the 428 reports open at the end of the prior quarter. The amount of $36,534,000 potentially due DOE at the end of the quarter was $886,000 more than the $35,648,000 potentially due DOE at the end of the prior quarter. The amount potentially owed by DOE decreased from $669,000 at the end of the prior quarter to $585,000 at the end of the current quarter.

5650 **(GEPP-TIS—754b) Application of Honeywell Data Management IV system software.** Denty, M.A. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 14 Nov 1983. Contract AC04-76DP00656. 32p. NTIS, PC A03/MF A01. Order Number DE84002959.

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This paper describes the Honeywell Data Management IV (DMIV) software design and implementation approach used at the DOE Pinellas Plant (operated by the General Electric Neutron Devices Department) for two major on-line systems: one supporting purchasing and the general stockroom; the other supporting engineering product configuration definition and engineering drawing distribution control. Also included are data base administration practices, transaction processing considerations, data base design techniques, and an overview of the applications themselves. Problems solved and pitfalls avoided are also discussed.

5651 **(ORNL/PPA—83/10) Oak Ridge National Laboratory Institutional Plan FY 1984-FY 1989.** (Oak Ridge National Lab., TN (USA)). Nov 1983. Contract W-7405-ENG-26. 140p. NTIS, PC A07/MF A01. Order Number DE84003153.

In this plan, Oak Ridge National Laboratory (ORNL) continues to be committed to scientific and technological research that is based on technical excellence and innovation and that provides a foundation for and a stimulus to broader and more sustained economic growth. DOE is being asked to assist in establishing a new program for Laboratory cooperation with industry, beginning with an initial focus on materials science. The current Institutional Plan thus projects growth in the materials science area as well as in other basic physical science areas and suggests a new initiative designed to extend the various technology transfer activities and to make them more effective by using ORNL as the trial Laboratory for some of these different approaches. This Institutional Plan projects a stable future for ORNL, with only modest amounts of growth in selected areas of research for the FY 1984-FY 1989 planning cycle. Summaries of the overall picture of the proposed budget and personnel levels for the current planning cycle are included. Scientific programs, laboratory resource development, and private sector interactions are discussed.

5652 **DOE prohibited personnel practices. Joint hearing before the Subcommittee on Energy Conservation and Power of the Committee on Energy and Commerce and the Subcommittee on Civil Service of the Committee on Post Office and Civil Service, House of Representatives, Ninety-Eighth Congress, First Session, April 19, 1983.** Washington, DC; Government Printing Office (1983). 297p.

DOE disregarded Congressional mandates when it dismantled the Conservation and Renewable Energy Office by reducing personnel levels and reorganizing management to eliminate selected professional. A hearing to review this development heard testimony from senior DOE personnel who were affected, DOE personnel management, the Merit Systems Protection Board, and others. Joseph Tribble, Assistant Secretary for Conservation and Renewable Energy defended the reorganization on economic grounds. (DCK)

9902 Mathematics And Computers

REFER ALSO TO CITATION(S) 5148

5653 **(CONF-830873—2) Software parts in Fortran 8x.** Smith, B.T. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE84003621.

From IFIP PDE software conference; Soderkoping, Sweden (22 Aug 1983).

This paper briefly describes the data abstraction mechanisms that have been proposed by the Fortran Standards Subcommittee X3J3 for Fortran 8x. With the proposed mechanisms, the building of software parts, that is, components of subroutine libraries, data bases, and program packages, is greatly facilitated.

5654 **(LA-UR—83-3393) How to talk to your computer, literally.** Ford, W. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 8p. (CONF-8310182—5). NTIS, PC A02/MF A01. Order Number DE84003837.

From US fall DECUS symposium; Las Vegas, NV, USA (24 Oct 1983).

Voice I/O is a rapidly growing technology. The techniques are still in the formative stage and thus are still somewhat primitive. However, useful tasks can be accomplished within the limitations of today's hardware. No reference to specific hardware will be given, but guidelines for selecting and using hardware will be provided. The guidelines include vocabulary size, method of training, upload/ download capabilities, user control of recognition parameters, package form-factor, and information returned to the user. Hints will be given for working with hardware limitations. Some current and proposed uses for voice I/O at Los Alamos National Laboratory will be described. These applications include personnel identity ver-

ification, instrument control, data entry, alarm annunciation, and issuing operating system and editor commands.

5655 **(LA-UR—83-3394) Database transfers between several systems.** Doll, M. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 10p. (CONF-8310182—4). NTIS, PC A02/MF A01. Order Number DE84003841.

From US fall DECUS symposium; Las Vegas, NV, USA (24 Oct 1983).

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The ability to transfer databases between systems allows the user to exploit the best features of either system. This paper addresses beginning Datatrieve users and deals with the issues involved in a transfer of a database from a central computing area to a PDP-11 at the Los Alamos National Laboratory. FRAMIS was used to clean the original database; DATATRIEVE was used to establish the new database. The new database residing on the PDP-11 was subject to structural change at any time.

5656 **(LA-UR—83-3421) SAMPLE: software for VAX FORTRAN execution timing.** Lowe, L.H. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-8310182—10). NTIS, PC A02/MF A01. Order Number DE84003819.

From US fall DECUS symposium; Las Vegas, NV, USA (24 Oct 1983).

SAMPLE is a set of subroutines in use at the Los Alamos National Laboratory for collecting CPU timings of various FORTRAN program sections - usually individual subroutines. These measurements have been useful in making programs run faster. The presentation includes a description of the software and examples of its use. The software is available on the directory [SAMPLE] of the VAX SIG tape.

5657 **(SOL—83-17) Triangulations (tilings) and certain block triangular matrices.** Dantzig, G.B.; Hoffman, A.J.; Hu, T.C. (Stanford Univ., CA (USA). Dept. of Operations Research). Sep 1983. Contract AT03-76ER72018. 27p. NTIS, PC A03/MF A01. Order Number DE84003579.

The problem is to find a tiling (triangularization) of a convex n polytope (or combinatorially an n-gon) such that the partition uses the minimum number of tiles. We show that a certain linear program can be formulated whose optimal solution is always in integers and corresponds to a tiling. Moreover the system is in the form of a block-triangular Leontief-Substitution System that is readily solved by a $O(n^3)$ algorithm consisting of a single forward and backward pass through data.

5658 **(UCRL—89901) Coming computer revolution in the classroom and the workplace.** Miller, E.K. (Lawrence Livermore National Lab., CA (USA)). 5 Oct 1983. Contract W-7405-ENG-48. 7p. (CONF-8310214—1). NTIS, PC A02/MF A01. Order Number DE84002797.

From College industry education conference; Columbia, SC, USA (1 Oct 1983).

It has been nearly four decades since the appearance of the first electronic, tube-based, computer; two decades since the introduction of a large-scale solid-state computer; and seven years since the personal computer became available. In that relatively short time, the computer has already had a profound impact on almost all aspects of our lives, an impact that can only be expected to grow in future years. Two areas of impact are of particular interest in our prediction about the coming computer revolution: engineering applications and engineering education. We speculate briefly on the near-term evolution of computer technology and how it may affect these areas of engineering. As a focal point, the discussion concentrates specifically on the power of computer graphics and computer interactivity.

5659 **(UCRL—89939) Large scale computations.** Goudreau, G.L. (Lawrence Livermore National Lab., CA (USA)). Oct 1983. Contract W-7405-ENG-48. 48p. (CONF-8310213—1). NTIS, PC A03/MF A01. Order Number DE84002763.

From Workshop on the theoretical foundation of large scale computations on nonlinear material behavior; Evanston, IL, USA (24 Oct 1983).

The central ingredients of general codes for large scale nonlinear material computation are reviewed as a focus and complement to other presentations on the theory and implementation of constitutive models. Spatial discretization by the simplest finite elements is discussed relative to integral differences andl higher order finite element alternatives. Explicit and implicit transient integration strategies are evaluated. Contact sliding algorithms, rezoning, and vectorization are included as important aspects of large scale computing. A few examples are included. 68 references.

5660 **(UIUCDCS-R—83-1130) Numerical methods for smooth solutions of ordinary differential equations.** Vu, T.V. (Illinois Univ., Urbana (USA). Dept. of Computer Science). May 1983. Contract AC02-76ER02383. 109p. (UILU-ENG—83-1709; COO—2383-0094). NTIS, PC A06/MF A01. Order Number DE84002184.

Thesis.

This thesis deals with the smoothness of the numerical solution of ordinary differential equations with respect to parameter variations. Numerical methods and techniques are developed to attain smooth solutions along mesh trajectories and at a fixed point in time. The methods are based on modifications of the Runge-Kutta methods and the Taylor's series methods. Error bounds for smooth one-step methods are also obtained. These bounds assure the same order of convergence in the derivatives as in the solution. A smooth, automatic integrator named RKTSOL is written in FORTRAN 77 to implement the methods discussed. Limited numerical results indicate that this code outperforms nonsmooth codes such as RKF45 and LSODE in computing numerical solutions for approximations to partial derivatives with respect to parameters.

5661 **(UIUCDCS-R—83-1131) Comparison of the Nordsieck and Modified Divided Difference storage methods in the computer solution of ODES.** Shilling, J. (Illinois Univ., Urbana (USA). Dept. of Computer Science). May 1983. Contract AC02-76ER02383. 94p. (UILU-ENG—83-1710; COO—2383-0095). NTIS, PC A05/MF A01. Order Number DE84002947.

This report details some of the results of a study which was carried out to compare the relative merits of two methods for storing the interpolating polynomial in a numeric ordinary differential equation integrator. The two storage schemes which we compare are the Nordsieck method and the Modified Divided Difference Method. In order to compare these methods under fair conditions we constructed two ODE integrators which are identical except for the storage scheme for the interpolating polynomial and the differences which cannot be avoided because of the storage scheme. We chose as our test problem set the stiff and nonstiff problem sets proposed by Enright, Hull, et al. [HUEN72,ENHU75] for use in the comparison of ODE integrators. We tested our packages through Enright and Hull's package DETEST. It is from that code that we obtain our statistics for time, error, etc. The testing was performed on the Prime 650 under the PRIMOS operating system.

9903 Information Handling

REFER ALSO TO CITATION(S) 4853, 5650

5662 **Fastbus for data aquisition and control.** Costrell, L.; Dawson, W.K. (Nat.'l Bureau of Standards, the Nuclear Research Center, Washington, DC 20234). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-30**: No. 4, 2147-2151(Aug 1983).

FASTBUS is a standardized modular data-bus system for data acqusition, data processing and control applications. It is the result of an interlaboratory development undertaken to meet the needs of the high energy physics community. However, the versatility, speed and addressing capability of FASTBUS make it attractive for many other types of application. A FASTBUS system consists of bus Segments which operate independently but dynamically link together as needed for operation passing. This parallel processing feature accounts to a great extent for the high throughput of

FASTBUS in multisegment systems. Master modules compete for single or multiple Segment Control through a bus arbitration scheme using assigned priorities. Logical, geographical, secondary and broadcast addressing methods are used to access either data space or control and status register space. Features include block transfers, a sparse data scan and interrupts.

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The notations in the final parentheses indicate the type of document, e.g., R for Report; the country of publication, e.g., US; and the language if other than English, e.g., In German. Tables of document types and country of publication codes appear after the indexes.

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, VA 22161.

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AC11-76PN00014	**Bettis Atomic Power Lab., West Mifflin, PA (USA)**	
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AC12-76SN00052	**Knolls Atomic Power Lab., Schenectady, NY (USA)**	
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AC15-76CL02395	**Westinghouse Advanced Reactors Division, Madison, PA**	
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AC15-76CL50003	**Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.**	
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AC19-79BC10079	**University of Tulsa**	
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AC21-81MC16310	**Kansas State Univ., Manhattan (USA). Dept. of Chemical Engineering**	
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AC22-79ET14700	**Utah Univ., Salt Lake City (USA). Dept. of Mining and Fuels Engineering**	
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AC22-81PC40785	**SRI International, Menlo Park, CA (USA)**	
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AI01-78CS54231	**Southwest Research Inst., San Antonio, TX (USA)**	
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AI01-80CS40453	**National Fertilizer Development Center, Muscle Shoals, AL (USA)**	
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AI08-78ET44802	**Geological Survey, Denver, CO (USA)**	
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AI08-79DP40092	**Naval Research Lab., Washington, DC (USA)**	
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AS05-76ER03948	**Houston Univ., TX (USA). Dept. of Physics**	
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AS05-76ER03992	**Texas Univ., Austin (USA). Center for Particle Theory**	
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AS05-76ER05096	**Rice Univ., Houston, TX (USA). Bonner Nuclear Labs.**	
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AS05-77SR01012	**South Carolina Univ., Columbia (USA). Coll. of Engineering**	
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AS05-78ER06043	**Texas A and M Univ., College Station (USA). Dept. of Physics**	
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AS05-80ER10618	**Vanderbilt Univ., Nashville, TN (USA)**	
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AS05-82ER12044	**Southwest Research Inst., San Antonio, TX (USA)**	
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AS05-82NE37900	**Auburn Univ., AL (USA). Dept. of Mechanical Engineering**	
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AS05-83DP48013	**Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Management Systems Labs.**	
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AT01-79CS10047	**Jet Propulsion Lab., Pasadena, CA (USA)**	
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AT03-76ER70057	**Dept. of Materials Science and Engineering, Stanford Univ., Stanford, CA**	
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AT03-76ER72018	**Stanford Univ., CA (USA). Dept. of Operations Research**	
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AT03-76ET12075	**Doschers Group Inc.**	
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AT03-76ET35301	**GA Technologies, Inc., San Diego, CA (USA)**	
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AT03-76SF70046	**GA Technologies, Inc., San Diego, CA (USA)**	
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AT03-80ER52061	University of California, Los Angeles School of Engineering and Applied Science, Los Angeles, Califo	
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FC05-77ET10069	Exxon Research and Engineering Co., Florham Park, NJ (USA)	
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FC07-79ID12044	Oregon State Dept. of Geology and Mineral Industries, Portland (USA)	
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FC22-83FE60339	Southern Illinois Univ., Carbondale (USA). Coal Extraction and Utilization Research Center	
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FG01-78CS01220	Massachusetts State Labor Council, AFL-CIO, Boston (USA)	
	9:4786	DOE/CS/01220—T1
FG01-79IR10264	Scientific Applications, Inc., Oakmont, PA (USA)	
	9:4857	DOE/IR/10264—T1
FG01-79RG10189	Idaho Dept. of Water Resources, Boise (USA)	
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FG01-81AD11260	Wilberforce Univ., OH (USA)	
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FG01-81RA50574		
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FG02-79ER10546	California State Univ., Fullerton	
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FG02-82ER12079	Marine Biological Lab., Woods Hole, MA (USA)	
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FG05-78ER10098	Tuskegee Inst., AL (USA). School of Engineering	
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FG05-81OR20808	Renewable Energy, Inc., Paducah, KY (USA)	
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FG22-80PC30213	Wisconsin Univ., Madison (USA). Dept. of Mechanical Engineering	
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FG22-81PC40799	Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemistry	
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FG22-81PC40809	Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry	
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FG22-82PC50786	Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.	
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FG22-82PC50798	Colorado Univ., Boulder (USA)	
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FG22-82PC50799	Delaware Univ., Newark (USA). Dept. of Chemical Engineering	
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FG22-82PC50800	Illinois Univ., Urbana (USA). Dept. of Chemistry	
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FG22-83PC60807	Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry	
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FG44-80R410153	Granger (James A.), Tallahassee, FL (USA)	
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FG44-80R410158	Holloman (Randy L.) and Associates, Valdosta, GA (USA)	
	9:4519	DOE/R4/10158—T1
FG46-79R610947	Keel (James S.), Harrison, AR (USA)	
	9:4507	DOE/R6/10947—T1
FG46-79R610949	Wood (Harry E.) and Associates, New Orleans, LA (USA)	
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FG46-79R610953	Verdel (Thomas H.), Oklahoma City, OK (USA)	
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FG46-79R610958	Austin (William S.), Fort Worth, TX (USA)	
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FG46-79R610959	Earth Lab Systems, Alamogordo, NM (USA)	
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FG46-79R610962	Goulden (Darrell R.), Yukon, OK (USA)	
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FG46-79R610965	Webb (L. Dale), College Station, TX (USA)	
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FG46-79R610974	McCants (Thomas W.), Animas, NM (USA)	
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FG46-79R610985	Lufkin, City of, TX (USA)	
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FG46-79R610986	Halff (Albert H.) Associates, Inc., Dallas, TX (USA)	
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FG46-79R610987	Marlin Chamber of Commerce, TX (USA)	
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FG46-79R610997	San Jacinto Coll., Pasadena, TX (USA)	
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FG46-79R611000	Connors State Coll., Warner, OK (USA)	
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FG46-80R612001	Barry (Simmons J.) and Associates, Inc., Baton Rouge, LA (USA)	
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FG46-80R612005	Hair (Michael), Lafayette, LA (USA)	
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FG46-80R612006	University of Southwestern Louisiana, Lafayette (USA)	
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FG46-80R612009	Hyacinthetics Corp., Lake Charles, LA (USA)	
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FG46-80R612010	Minn (Howard S.), Lake Charles, LA (USA)	
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FG46-80R612017	Campbell (D.A.), Silver City, NM (USA)	
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FG46-80R612019	Calentine (Della D.), Las Vegas, NM (USA)	
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FG46-80R612025	Soil-crete Solar Co., Navajo Dam, NM (USA)	
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FG46-80R612026	New Mexico Univ., Albuquerque (USA). Engineering Research Inst.	
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FG46-80R612039	Farrar (Blake R.), Norman, OK (USA)	
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FG46-80R612041	Thomas (G. Richard), Stillwater, OK (USA)	
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FG46-80R612043	Oklahoma Univ., Norman (USA). School of Chemical Engineering and Materials Science	
	9:4521	DOE/R6/12043—T1
FG46-80R612048	Scientific Services, Austin, TX (USA)	
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FG46-80R612049	O'Hara (James C.), Corpus Christi, TX (USA)	
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FG46-80R612053	Smith (Jesse B.), Garland, TX (USA)	
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FG46-80R612055	Community Development Corp., Brownsville, TX (USA)	
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FG46-80R612057	Lamar Univ., Beaumont, TX (USA). Dept. of Mechanical Engineering	
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FG46-80R612058	Texas Tech Univ., Lubbock (USA). Dept. of Civil Engineering	
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FG46-80R612060	**West Texas State Univ., Canyon (USA). Alternative Energy Inst.**	
	9:4564	DOE/R6/12060—T1
FG46-80R612062	**Hill Country Youth Ranch, Ingram, TX (USA)**	
	9:4877	DOE/R6/12062—T1
FG46-81AF92504	**VIA, Inc., Albuquerque, NM (USA)**	
	9:4524	DOE/AF/92504—T1
FG46-81AF92505	**Byng Public School, Ada, OK (USA)**	
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FG46-81AF92506	**Mitchell (Richard S.), Jonesboro, AR (USA)**	
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FG46-81AF92507	**Boone Enterprises, Inc., Baton Rouge, LA (USA)**	
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FG46-81R612012	**University of Southwestern Louisiana, Lafayette (USA). Dept. of Microbiology**	
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FG46-81R612014	**Louisiana State Univ., Baton Rouge (USA)**	
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	Braud (Harry J.), Gonzales, LA (USA)	
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FG46-81R612029	**Muscogee (Creek) Nation, Okmulgee, OK (USA). Div. of Tribal Affairs**	
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FG46-81R612031	**Oklahoma State Univ., Stillwater (USA). School of Electrical and Computer Engineering**	
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FG46-81R612032	**Oklahoma State Univ., Stillwater (USA). Dept. of Agricultural Engineering**	
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FG46-81R612076	**England (Bill), Hawley, TX (USA)**	
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FG46-81R612078	**Electronic Flo-Meters, Inc., Dallas, TX (USA)**	
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FG46-81R612080	**Travis County Extension Energy Committee, Austin, TX (USA)**	
	9:4913	DOE/R6/12080—T1
FG46-81R612083	**Ana-Lab Corp., Kilgore, TX (USA)**	
	9:4510	DOE/R6/12083—T1
FG46-81R612085	**Tarleton State Univ., Stephenville, TX (USA)**	
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W-31-109-ENG-38	**Argonne National Lab., IL**	
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	Oak Ridge National Lab., TN (USA)	
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W-7405-ENG-36	**Los Alamos National Lab., NM (USA)**	
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4	*See* BNL-33523	DE84002875	MN -37	9:5338
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57	NTIS, PC A02/MF A01	DE84003571	MN -25	9:4939
58	NTIS, PC A02/MF A01	DE84003713	MN -25	9:4940
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3	*See* UCRL-89454	DE84002800	MN -34A	9:5529
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40	*See* EGG-M-08383	DE84000885	MN -78	9:4713
42	NTIS, PC A02/MF A01	DE84000645	MN -78	9:4707
43	*See* EGG-M-16583	DE84000889	MN -78	9:4720
CONF-830822-	(12. international conference on high energy accelerators, Batavia, IL, USA, 11-16 Aug 1983)			
40	*See* LBL-16019	DE84003042	MN -28	9:5210
41	*See* LBL-16498	DE84002917	MN -28	9:5247
CONF-830873-	(IFIP PDE software conference, Soderkoping, Sweden, 22-26 Aug 1983)			
2	NTIS, PC A02/MF A01	DE84003621	MN -32	9:5653
CONF-830874-	(27. annual international technical symposium on high speed photography, videography and photonics, San Diego, CA, USA, 21-26 Aug 1983)			
31	*See* UCRL-89020	DE84002798	MN -21	9:5600
CONF-8308106-	(5. annual participants information meeting of DOE low level waste management program, Denver, CO, USA, 30 Aug-1 Sep 1983)			
24	*See* BNL-NUREG-33777	DE84002878	MN -70B	9:4441
CONF-8308112-	(3. international Swarm seminar, Innsbruck, Austria, 3-5 Aug 1983)			
4	NTIS, PC A02/MF A01; 1	DE84003383	MN -34A	9:5454
CONF-8308126-	(NRC research annual review meeting of nuclear waste management research on geochemistry of HLW disposal, Reston, VA, USA, 30 Aug-1 Sep 1983)			
3	*See* BNL-NUREG-33580	DE84002853	MN -70	9:4481
CONF-8308131-	(3. international conference on physics in collision, Como, Italy, 31 Aug-2 Sep 1983)			
3	*See* ANL-HEP-CP-83-59	DE84003651	MN -34D	9:5474
CONF-8308132-	(NATO/CAP institute on moment formation in solids, Vancouver Island, Canada, 21 Aug-2 Sep 1983)			
2	NTIS, PC A02/MF A01	DE84003705	MN -25	9:5538
CONF-8308139-	(9. Hawaii topical conference in particle physics, Honolulu, HI, USA, 11-24 Aug 1983)			
1	*See* BROWN/HET-516	DE84001291	MN -34D	9:5485
CONF-830901-	(Anticipated and abnormal plant transients in light water reactors conference, Jackson, WY, USA, 26-29 Sep 1983)			
10	*See* EGG-M-12883	DE84000803	MN -78	9:4714
19	*See* EGG-M-05583	DE84002157	MN -78	9:4712
CONF-830910-	(3. national conference on synchrotron radiation instrumentation, Upton, NY, USA, 12-14 Sep 1983)			
6	*See* LBL-16554	DE84003044	MN -28	9:5248
7	NTIS, PC A03/MF A01	DE84003286	MN -28	9:5242
8	*See* BNL-33872	DE84003677	MN -37	9:5341
CONF-830932-	(International conference on numerical methods in nuclear engineering, Montreal, Canada, 6-9 Sep 1983)			
6	*See* EGG-M-16183	DE84000801	MN -78	9:4718
CONF-830934-	(4. Pacific Basin nuclear conference, Vancouver, Canada, 11-15 Sep 1983)			
1	*See* SAND-83-1695C	DE84003253	MN -70B	9:4456
CONF-830936-	(Symposium on atomic spectroscopy (SAS-83), Berkeley, CA, USA, 12-16 Sep 1983)			
3	*See* DOE/ER/10618-9	DE84003754	MN -34A	9:5457
CONF-830942-	(3. topical meeting on fusion reactor materials, Albuquerque, NM, USA, 19-23 Sep 1983)			
59	*See* HEDL-SA-2911-FP	DE84002116	MN -20c	9:4971
60	*See* SAND-83-1346C	DE84002170	MN -20c	9:5596
61	NTIS, PC A02/MF A01; 1	DE84003625	MN -25	9:5581

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CONF-830969-	(12. international conference on solid state nuclear track detectors, Acapulco, Mexico, 4-10 Sep 1983)			
4	*See* HEDL-SA-2865-FP	DE84001485	MN -79m	9:4684
9	*See* UCRL-89073	DE84002461	MN -21	9:5601
CONF-8309105-	(International seminar on criticality experiments and data, Dijon, France, 20-23 Sep 1983)			
1	*See* PNL-SA-11251	DE84001551	MN -46	9:5089
CONF-8309118-	(Topical meeting on free electron generation of extreme ultraviolet coherent radiation, Upton, NY, USA, 19-22 Sep 1983)			
1	*See* LBL-16640	DE84002889	MN -28	9:5115
3	*See* BNL-33813	DE84002869	MN -34A	9:5317
CONF-8309156-	(7. meeting of the international collaboration on advanced neutron sources, Ontario, Canada, 12-16 Sep 1983)			
8	NTIS, PC A02/MF A01	DE84003576	MN -28	9:5244
11	NTIS, PC A02/MF A01	DE84003613	MN -28	9:5245
CONF-8309162-	(5. annual EOS/ESD symposium, Las Vegas, NV, USA, 27-29 Sep 1983)			
2	*See* UCRL-89147	DE84002470	MN -38	9:5150
CONF-8309168-	(3. international conference on ultra-relativistic nucleus-nucleus collisions, Upton, NY, USA, 26-30 Sep 1983)			
2	*See* BNL-33839	DE84002884	MN -34C	9:5476
CONF-8309183-	(Erice conference on nucleosynthesis, Erice, Italy, 9 Sep 1983)			
1	*See* UCRL-89841	DE84002787	MN -34B	9:5448
CONF-8309184-	(NATO Advanced Research Institute conference on inverse methods in electromagnetic imaging, Bad Windsheim, F.R. Germany, 18-24 Sep 1983)			
1	*See* UCRL-89635	DE84002793	MN -34	9:5140
CONF-831015-	(Nuclear science symposium, San Francisco, CA, USA, 19-21 Oct 1983)			
20	*See* BNL-33858	DE84002863	MN -38	9:5340
21	*See* BNL-33766	DE84002873	MN -37	9:5339
22	*See* BNL-33907	DE84003163	MN -37	9:5342
23	NTIS, PC A02/MF A01	DE84003326	MN -34C	9:5343
24	*See* PNL-SA-11358	DE84003342	MN -37	9:5347
CONF-831025-	(26. ORNL-DOE conference on analytical chemistry in energy technology, Knoxville, TN, USA, 11-13 Oct 1983)			
26	NTIS, PC A02/MF A01	DE84003717	MN -70	9:4482
CONF-831047-	(American Nuclear Society winter meeting, San Francisco, CA, USA, 30 Oct-4 Nov 1983)			
96	*See* PNL-SA-11420	DE84002589	MN -78	9:4757
102	*See* EGG-M-13883	DE84002223	MN -80	9:4715
106	*See* EGG-M-14283	DE84002222	MN -78	9:4716
110	NTIS, PC A02/MF A01	DE84003279	MN -41	9:5369
112	*See* BNL-NUREG-33833	DE84003806	MN -78	9:4705
CONF-831049-	(International seminar on indoor exposure to natural radiation and related risk assessment, Capri, Italy, 3-5 Oct 1983)			
1	*See* LBL-16636	DE84002928	MN -11	9:5373
CONF-831063-	(American Institute of Chemical Engineers fall annual meeting, Washington, DC, USA, 30 Oct-3 Nov 1983)			
8	*See* MLM-3116(OP)	DE84002838	MN -90c	9:4292
9	*See* LBL-16795	DE84002890	MN -70	9:4449
10	NTIS, PC A03/MF A01	DE84003398	MN -90d	9:4279
CONF-831086-	(Electrochemical Society fall meeting, Washington, DC, USA, 9-14 Oct 1983)			
7	*See* SAND-83-1082C	DE84002106	MN -94c	9:4775
8	*See* SAND-83-0979C	DE84003103	MN -94cb	9:4774
CONF-8310102-	(Instrument Society of America conference and exhibit, Houston, TX, USA, 10-13 Oct 1983)			
3	*See* EGG-M-15483	DE84002225	MN -80	9:4657
CONF-8310104-	(Specialists meeting on yields and decay data of fission product nuclides, Upton, NY, USA, 24-27 Oct 1983)			
4	*See* DOE/ER/10493-13	DE84003419	MN -34	9:5502
5	*See* PNL-SA-11747	DE84003348	MN -34C	9:5504
CONF-8310110-	(Conference on families and energy: coping with uncertainty, East Lansing, MI, USA, 9-11 Oct 1983)			
1	*See* LBL-16644	DE84003036	MN -95d	9:4879
2	*See* LBL-16657	DE84002907	MN -95d	9:4880
3	*See* LBL-16669	DE84002912	MN -95d	9:4881
CONF-8310111-	(11. DOE annual compatibility meeting, Livermore, CA, USA, 18-20 Oct 1983)			
7	*See* UCRL-89358	DE84002150	MN -4	9:4979
CONF-8310121-	(SPE annual technical conference, San Francisco, CA, USA, 5-8 Oct 1983)			
6	*See* LBL-16574	DE84002913	MN -66b	9:4551
CONF-8310143-	(11. NRC water reactor safety research information meeting, Gaithersburg, MD, USA, 14-28 Oct 1983)			
7	*See* SAND-83-1834C	DE84001545	MN -78	9:4759
23	*See* SAND-83-1823C	DE84002044	MN -78	9:4758
33	*See* EGG-M-21483	DE84002113	MN -78	9:4727
34	*See* EGG-M-20683	DE84002216	MN -80	9:4723
36	*See* EGG-M-20783	DE84002214	MN -78	9:4724
37	*See* EGG-M-22183	DE84002204	MN -78	9:4729
39	*See* EGG-M-20083	DE84002205	MN -78	9:4721

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40	*See* EGG-M-21583	DE84002208	MN -78	9:4728
41	*See* EGG-M-21283	DE84002209	MN -78	9:4726
42	*See* EGG-M-22583	DE84002207	MN -78	9:4731
43	*See* EGG-M-20583	DE84002217	MN -78	9:4722
44	*See* EGG-M-20883	DE84002164	MN -78	9:4725
45	*See* EGG-M-21983	DE84002203	MN -80	9:4658
46	*See* EGG-M-22083	DE84002632	MN -80	9:4659
48	*See* EGG-M-22283	DE84002211	MN -78	9:4730
51	*See* PNL-SA-11656	DE84003350	MN -41	9:5400
54	NTIS, PC A04/MF A01	DE84003327	MN -78	9:4643
CONF-8310144-	(Specialists' workshop on fission gas behavior in safety experiments, Cadarache, France, 5-7 Oct 1983)			
3-Rev.	NTIS, PC A03/MF A01	DE84003715	MN -2	9:4656
CONF-8310157-	(29. annual conference on bioassay, analytical and environmental chemistry, Seattle, WA, USA, 12-13 Oct 1983)			
2	*See* EGG-M-15283	DE84002894	MN -4	9:5056
3	*See* LA-UR-83-3385	DE84003835	MN -70	9:4483
CONF-8310163-	(18. international thermal conductivity conference, Rapid City, SD, USA, 3-5 Oct 1983)			
9	*See* SAND-83-1141C	DE84002104	MN -4	9:5137
CONF-8310172-	(Advances in soft x-ray science and technology conference, Upton, NY, USA, 17-20 Oct 1983)			
3	*See* BNL-33895	DE84002876	MN -4	9:5052
4	*See* BNL-33978	DE84003264	MN -25	9:5034
5	NTIS, PC A02/MF A01	DE84003328	MN -34	9:5351
CONF-8310182-	(US fall DECUS symposium, Las Vegas, NV, USA, 24-28 Oct 1983)			
4	*See* LA-UR-83-3394	DE84003841	MN -32	9:5655
5	*See* LA-UR-83-3393	DE84003837	MN -32	9:5654
9	*See* LA-UR-83-3444	DE84003817	MN -28	9:5246
10	*See* LA-UR-83-3421	DE84003819	MN -32	9:5656
CONF-8310187-	(IEEE ultrasonics symposium, Atlanta, GA, USA, 31 Oct-2 Nov 1983)			
1	*See* UNI-SA-116	DE84001770	MN -80	9:4702
CONF-8310197-	(DOE reproductive toxicology workshop, San Francisco, CA, USA, 12-14 Oct 1983)			
2	NTIS, PC A02/MF A01	DE84003673	MN -48	9:5425
CONF-8310198-	(IAEA specialists on mechanical properties of structural materials, Chester, UK, 10-14 Oct 1983)			
2	NTIS, PC A03/MF A01; 1	DE84001960	MN -79h	9:4598
CONF-8310199-	(Rivers '83 symposium, New Orleans, LA, USA, 24-26 Oct 1983)			
2	NTIS, PC A02/MF A01	DE84003627	MN -38	9:5431
CONF-8310205-	(TMS-AIME fall meeting, Philadelphia, PA, USA, 2-6 Oct 1983)			
2	*See* BNL-NUREG-33841	DE84002855	MN -25	9:4934
CONF-8310212-	(34. meeting of the Aeroballistic Range Association, Williamsburg, VA, USA, 5-6 Oct 1983)			
1	*See* UCRL-89852	DE84002452	MN -38	9:5092
CONF-8310213-	(Workshop on the theoretical foundation of large scale computations on nonlinear material behavior, Evanston, IL, USA, 24-26 Oct 1983)			
1	*See* UCRL-89939	DE84002763	MN -32	9:5659
CONF-8310214-	(College industry education conference, Columbia, SC, USA, 1 Oct 1983)			
1	*See* UCRL-89901	DE84002797	MN -32	9:5658
CONF-8310217-	(WANTO meeting, Miamisburg, OH, USA, 10-14 Oct 1983)			
1	*See* SAND-83-2326C	DE84002801	MN -38	9:5138
CONF-8310218-	(11. Society of Optical Engineers conference on thermosense, Chicago, IL, USA, 2-5 Oct 1983)			
1	*See* MLM-3118(OP)	DE84002837	MN -4	9:5075
CONF-8310219-	(EIVR-37 meeting, Livermore, CA, USA, 25 Oct 1983)			
1	*See* SAND-83-2377C	DE84002804	MN -38	9:5090
CONF-831105-	(Meeting of the Plasma Physics Division of the American Physical Society, Los Angeles, CA, USA, 7-11 Nov 1983)			
3	NTIS, PC A05/MF A01	DE84003274	MN -20b	9:5550
CONF-831106-	(Topical meeting on safeguards technology - the process safeguards interface, Hilton Head Island, SC, USA, 28 Nov-1 Dec 1983)			
3	*See* SAND-83-2392C	DE84003211	MN -15	9:4489
4	*See* LA-UR-83-3386	DE84003834	MN -15	9:4488
6	*See* LA-UR-83-3381	DE84003182	MN -15	9:4487
CONF-831111-	(ASME winter annual meeting, Boston, MA, USA, 13-18 Nov 1983)			
11	*See* UCRL-89646	DE84003002	MN -25	9:5031
12	*See* BNL-33865	DE84002868	MN -20c	9:5579
CONF-831130-	(Technical committee meeting on inertial confinement fusion research, Osaka, Japan, 7-11 Nov 1983)			
1	*See* SAND-83-2382C	DE84002109	MN -21	9:5597
CONF-831142-	(Automotive technology development contractor coordination meeting, Dearborn, MI, USA, 13-17 Nov 1983)			
1	NTIS, PC A02/MF A01	DE84003281	MN -25	9:5030
CONF-831151-	(State-of-the-art and emerging technologies: a waste-to-energy workshop, Chicago, IL, USA, 28-30 Nov 1983)			
1	NTIS, PC A02/MF A01	DE84003580	MN -95e	9:4910

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CONF-831155-	(Symposium on flue gas desulfurization, New Orleans, LA, USA, 1-4 Nov 1983)			
2	NTIS, PC A02/MF A01	DE84003636	MN -11	9:4333
CONF-831171-	(American Vacuum Society meeting, Boston, MA, USA, 1-4 Nov 1983)			
14	*See* PNL-SA-11465	DE84003347	MN -25	9:4453
15	NTIS, PC A02/MF A01	DE84003308	MN -20a	9:5551
CONF-831174-	(Materials Research Society annual meeting, Boston, MA, USA, 14-17 Nov 1983)			
3-Rev.1	*See* UCRL-89404-Rev.1	DE84003004	MN -70	9:4457
11	*See* SAND-83-1400C	DE84003105	MN -25	9:5149
12	*See* SAND-83-1388C	DE84003106	MN -4	9:5078
13	*See* SAND-83-1234C	DE84002252	MN -25	9:4977
14	*See* SAND-83-1567C	DE84002103	MN -25	9:5039
15	*See* SAND-83-1422C	DE84002174	MN -25	9:5027
16	*See* DP-MS-83-72	DE84003031	MN -70	9:4446
17	*See* UCRL-89360	DE84003247	MN -25	9:4980
18	*See* SAND-83-1398C	DE84002173	MN -34A	9:5528
19	*See* PNL-SA-11504	DE84003352	MN -25	9:5025
20	*See* PNL-SA-11554	DE84003353	MN -70	9:5038
21	NTIS, PC A02/MF A01; 1	DE84003397	MN -70B	9:4442
22	NTIS, PC A02/MF A01	DE84003252	MN -25	9:5035
24	NTIS, PC A02/MF A01	DE84003568	MN -25	9:5020
25	*See* PNL-SA-11770	DE84003343	MN -70	9:4454
26	*See* SAND-83-1291C	DE84003251	MN -25	9:5026
33	*See* PNL-SA-11415	DE84003598	MN -70	9:4452
CONF-831180-	(3. international symposium on the production and neutralization of negative ions and beams, Upton, NY, USA, 14-18 Nov 1983)			
2	*See* UCRL-89586	DE84003008	MN -4	9:5460
4	NTIS, PC A02/MF A01	DE84003285	MN -28	9:5243
CONF-831187-	(MMM conference, Pittsburgh, PA, USA, 8-11 Nov 1983)			
9	*See* BNL-33764	DE84002879	MN -34C	9:5033
10	*See* BNL-33827	DE84002874	MN -34C	9:4932
11	*See* BNL-33849	DE84002857	MN -34C	9:4933
12	NTIS, PC A02/MF A01	DE84003283	MN -25	9:4941
14	*See* LA-UR-83-3443	DE84003816	MN -25	9:4973
15	NTIS, PC A02/MF A01	DE84003552	MN -34D	9:4942
CONF-831189-	(ORSA/TIMS joint national meeting, Orlando, FL, USA, 7-9 Nov 1983)			
2	NTIS, PC A03/MF A01	DE84003553	MN -96	9:4923
CONF-831195-	(International congress on applications of lasers and electro-optics, Los Angeles, CA, USA, 14-17 Nov 1983)			
3	*See* LA-UR-83-3391	DE84003838	MN -48	9:5398
CONF-831199-	(3. Electric Power Research Institute annual contractors' conference on coal gasification, Palo Alto, CA, USA, 2-3 Nov 1983)			
2	NTIS, PC A02/MF A01	DE84003616	MN -90c	9:5021
CONF-8311102-	(International conference on radiation disinfestation of food and agricultural products, Honolulu, HI, USA, 14-18 Nov 1983)			
1	*See* UCRL-89825	DE84002454	MN -23	9:4496
CONF-8311103-	(2. annual workshop on interactive computing, Washington, DC, USA, 30 Nov-2 Dec 1983)			
1	*See* UCRL-89870	DE84002456	MN -38	9:5093
CONF-8311104-	(Physics of explosives technical meeting, Unterluss, F.R. Germany, 2-4 Nov 1983)			
1	*See* UCRL-89845	DE84002781	MN -45	9:5361
CONF-8311105-	(DOE/CEA meeting on defense waste management, Knoxville, TN, USA, 9-10 Nov 1983)			
1	*See* UNI-SA-118	DE84002337	MN -70A	9:4458
2	*See* DP-MS-83-114	DE84002620	MN -70	9:4447
3	NTIS, PC A03/MF A01	DE84003391	MN -70B	9:4443
CONF-831203-	(10. symposium on fusion engineering, Philadelphia, PA, USA, 5-9 Dec 1983)			
2	*See* UCRL-89234	DE84003244	MN -20a	9:5604
3	*See* UCRL-89264	DE84003243	MN -20b	9:5607
4	*See* UCRL-89231	DE84003245	MN -20b	9:5603
6	*See* LA-UR-83-3452	DE84003844	MN -20d	9:5593
7	*See* UCRL-89931	DE84003730	MN -20b	9:5609
8	*See* UCRL-89171	DE84003722	MN -20b	9:5602
9	*See* UCRL-89243	DE84003721	MN -20b	9:5605
10	*See* UCRL-89304	DE84003725	MN -20b	9:5608
11	*See* LA-UR-83-3439	DE84003815	MN -20d	9:5592
12	*See* UCRL-89259	DE84003724	MN -20b	9:5606
13	*See* UCRL-89319	DE84003728	MN -20b	9:5562
CONF-840116-	(63. annual meeting of Transportation Research Board, Washington, DC, USA, 16-20 Jan 1984)			
1	NTIS, PC A04/MF A01; 1	DE84004624	MN -96	9:4884
COO-				
2383-0094	*See* UIUCDCS-R-83-1130	DE84002184	MN -32	9:5660
2383-0095	*See* UIUCDCS-R-83-1131	DE84002947	MN -32	9:5661
3134-46	*See* DOE/ER/03134-46	DE84002243	MN -11	9:5435
3496-78	*See* DOE/ER/03496-78	DE83017895	MN -34C	9:5509
4326-5	*See* DOE/EV/04326-5	DE84003034	MN -48	9:5532

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CSIR-RR-588	NTIS (US Sales Only), PC A03/MF A01	DE83703860	MN -4	9:5053
CSIRO-DAG-GCM-25	Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia			9:4339
40	Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia			9:4340
43	Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia			9:4341
44	Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia			9:4342
DESY-SR-83-03	Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)			9:5455
DFVLR-MITT-83-01	*See* N-8325841			9:5154
DOE/AD/11260-T1	NTIS, PC A05/MF A01	DE84002233	MN -98	9:5392
DOE/AF/92504-T1	NTIS, PC A02/MF A01; 1	DE84003510	MN -61a	9:4524
DOE/AF/92505-T1	NTIS, PC A02/MF A01	DE84003500	MN -61a	9:4515
DOE/AF/92506-T1	NTIS, PC A02/MF A01	DE84003511	MN -61a	9:4516
DOE/AF/92507-T1	NTIS, PC A04/MF A01	DE84003499	MN -61a	9:4517
DOE/BETC-83/ 3	NTIS, PC A05/MF A01	DE84003596	STD -92a	9:4366
DOE/BETC/RI-83/ 9	NTIS, PC A04/MF A01	DE84003910	STD -92a	9:4367
DOE/CE-0027/ 1	NTIS, PC A02/MF A01	DE84002148	STD -96	9:4915
DOE/CE/40586-T1	NTIS, PC A06/MF A01	DE84002138	STD -95f	9:4887
DOE/CE/50305-3	NTIS, PC A03/MF A01; 1	DE84003906	STD -61	9:4518
DOE/CH/00178-T18	NTIS, PC A02/MF A01	DE84002239	STD -63	9:4525
DOE/CS/01220-T1	NTIS, PC A02/MF A01	DE84003049	MN -98	9:4786
DOE/CS/10047-T9	NTIS MF A01; 2	DE84003652	MN -93	9:4855
DOE/CS/30220-T1	NTIS, PC A11/MF A01; 1	DE84001862	STD -59c	9:4542
DOE/CS/30674-2	NTIS, PC A08/MF A01; 1	DE84003171	STD -66i	9:4552
DOE/CS/40294-T1	NTIS, PC A10/MF A01; 1	DE84002918	MN -95	9:4888
DOE/CS/40341-T4	NTIS, PC A10/MF A01; 1	DE84002936	MN -95f	9:4889
DOE/CS/40453-T1	NTIS, PC A03/MF A01; 1	DE84002244	MN -95f	9:4890
DOE/CS/50007-1-Vol.1	NTIS, PC A07/MF A01	DE84003905	STD -92b	9:4384
DOE/CS/54231-T1	NTIS MF A01; 2	DE84002434	MN -96	9:4928
DOE/DP/00789-T25	NTIS, PC A02/MF A01; 1	DE84001821	MN -62	9:4537
T26	NTIS, PC A06; 3	DE84001818	MN -62	9:4538
DOE/DP/40124-9	NTIS, PC A02/MF A01	DE84001266	MN -21	9:5582
DOE/EI/08607-T2	NTIS, PC A06/MF A01; 1	DE84002236	MN -98	9:4783
T3	NTIS, PC A09/MF A01; 1	DE84002234	MN -98	9:4784
DOE/EI/10085-T2	NTIS, PC A16/MF A01; 1	DE84002247	MN -98	9:4848
T3	NTIS, PC A14/MF A01	DE84002250	MN -98	9:4849
T4	NTIS, PC A12/MF A01	DE84002248	MN -98	9:4850
T5	NTIS, PC A04/MF A01; 1	DE84002246	MN -98	9:4851
DOE/EIA-0035(83/ 11)	NTIS, PC A06/MF A01	DE84003902	MN -98	9:4385
0226(83/ 08)	NTIS, PC A03/MF A01 - GPO	DE84002327	MN -98E	9:4841
0380(83/ 10)	NTIS, PC A06/MF A01; 1 - GPO	DE84002152	MN -98B	9:4386
0397(83/ 2Q)	NTIS, PC A14/MF A01 - GPO	DE84002689	MN -98E	9:4842
0404	NTIS, PC A05/MF A01 - GPO	DE84003189	MN -98C	9:4400
0418	NTIS, PC A06/MF A01 - GPO	DE84002942	MN -98	9:4852
0426	NTIS, PC A03/MF A01 - GPO	DE84002953	MN -98B	9:4785
DOE/EIS-0098	NTIS, PC A15/MF A01; 1	DE84002955	STD -11	9:5395
DOE/ER-0045/ 10	NTIS, PC A10/MF A01	DE84002405	STD -20c	9:5583
0178	NTIS, PC A03/MF A01	DE84002963	STD -11	9:5365
DOE/ER/02785-1	NTIS, PC A02/MF A01	DE84003173	MN -34C	9:5496

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DOE/ER/03134-46	NTIS MF A01; 2	DE84002243	MN -11	9:5435
DOE/ER/03274-4	NTIS, PC A07/MF A01; 1	DE83017104	MN -34C	9:5492
DOE/ER/03496-78	NTIS, PC A15/MF A01; 1	DE83017895	MN -34C	9:5509
DOE/ER/03948-15	NTIS, PC A03/MF A01; 1	DE84002835	MN -34D	9:5493
DOE/ER/03992-528	NTIS, PC A03/MF A01	DE84002847	MN -34D	9:5541
DOE/ER/04433-T1	NTIS, PC A02/MF A01	DE84003178	MN -38	9:5153
DOE/ER/05096-13	NTIS, PC A04/MF A01	DE84002423	MN -34D	9:5479
DOE/ER/06043-T1	NTIS, PC A02/MF A01	DE84002155	MN -34A	9:5456
DOE/ER/10098-T2	NTIS, PC A13/MF A01; 1	DE84003486	MN -63	9:4861
DOE/ER/10377-5	NTIS, PC A02/MF A01	DE84002175	MN -4	9:5054
DOE/ER/10482-T1	NTIS, PC A02/MF A01	DE84002004	MN -4	9:4930
DOE/ER/10493-13	NTIS, PC A03/MF A01; 1	DE84003419	MN -34	9:5502
DOE/ER/10598-4	NTIS, PC A02/MF A01	DE84002887	MN -25	9:5036
DOE/ER/10618-9	NTIS, PC A02/MF A01	DE84003754	MN -34A	9:5457
DOE/ER/10911-5	NTIS, PC A02/MF A01	DE84002886	MN -4	9:4526
DOE/ER/12012-2	NTIS, PC A04/MF A01	DE84003188	MN -34	9:5114
DOE/ER/12058-2	NTIS, PC A03/MF A01; 1	DE84003179	MN -4	9:4506
DOE/ER/12079-T1	NTIS, PC A06/MF A01; 1	DE83011525	MN -11	9:5403
DOE/ER/40033-B-55	NTIS, PC A02/MF A01; 1	DE84002946	MN -34D	9:5483
DOE/ER/40064-1	Inst. of Electrical and Electronic Engineers, Inc., 345 E. 47th St., New York, NY 10017			9:5316
DOE/ET/03425-23/ 24	NTIS, PC A04/MF A01; 1	DE84002885	MN -11	9:5366
DOE/ET/10069-T44	NTIS (US Sales Only), PC A04/MF A01	DE84002941	MN -90d	9:4280
DOE/ET/13005-T12	NTIS, PC A99/MF A01; 1	DE84003530	MN -90c	9:4281
DOE/ET/14700-16	NTIS, PC A04/MF A01	DE84002158	STD -90d	9:4282
DOE/ET/15440-16	NTIS, PC A03/MF A01; 1	DE84003765	STD -93	9:4856
DOE/ET/20195-T4	NTIS, PC A09/MF A01; 1	DE84002577	MN -94a	9:4539
DOE/ET/29661-2	NTIS, PC A05/MF A01; 1	DE84002626	MN -95b	9:4571
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DOE/EV/02958-7	NTIS, PC A03/MF A01	DE84003180	MN -48	9:5079
DOE/EV/04326-5	NTIS, PC A05/MF A01	DE84003034	MN -48	9:5532
DOE/EV/04959-5	NTIS, PC A02/MF A01	DE84003017	MN -4	9:5396
DOE/EV/13573-3	NTIS, PC A02/MF A01	DE84002948	MN -11	9:5370
DOE/FC/10297-T8	NTIS, PC A02/MF A01	DE84002641	MN -90c	9:4334
DOE/FE-0028	NTIS, PC A02/MF A01	DE84003987	STD -90d	9:4283
DOE/FE/60339-1	NTIS, PC A03/MF A01	DE84001789	STD -90e	9:4318
DOE/ID/12236-T1	NTIS, PC A07/MF A01	DE84003581	MN -25	9:4891
DOE/IR/10264-T1	NTIS, PC A05/MF A01; 1	DE84003156	MN -93	9:4857
DOE/LLW-25T	NTIS, PC A03/MF A01	DE84003853	STD -70B	9:4444
DOE/MA-0008/ 10	NTIS, PC A05/MF A01	DE84002605	MN -13	9:5649
DOE/MC/16310-1493	NTIS, PC A14/MF A01	DE84000224	STD -90c	9:4284
DOE/METC/SP-198	NTIS, PC A04/MF A01	DE84000215	STD -90c	9:4285
DOE/NE-0030/ 8	NTIS, PC A03/MF A01	DE84000816	MN -80	9:4627

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DOE/PC/30213-T4	NTIS, PC A03/MF A01	DE84001029	STD -90a	9:4349
DOE/PC/40785-9	NTIS, PC A03/MF A01	DE84003112	STD -90d	9:4287
DOE/PC/40799-T7	NTIS, PC A03/MF A01; 1	DE84002177	MN -90d	9:4319
DOE/PC/40809-18	NTIS, PC A05/MF A01	DE84002934	STD -90a	9:4320
DOE/PC/50786-6	NTIS, PC A02/MF A01	DE84002945	MN -90d	9:4288
DOE/PC/50798-5	NTIS, PC A02/MF A01	DE84003898	MN -90c	9:4289
DOE/PC/50799-T2	NTIS, PC A02/MF A01	DE84002139	MN -90d	9:4290
DOE/PC/50800-T4	NTIS, PC A02/MF A01	DE84002182	MN -90a	9:5472
DOE/PC/60785-1	NTIS, PC A02/MF A01	DE84003220	MN -90d	9:4321
DOE/PC/60807-1	NTIS, PC A02/MF A01	DE84002944	MN -90a	9:4322
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DOE/R6/10953-T1	NTIS, PC A02/MF A01	DE84003548	MN -95d	9:4863
DOE/R6/10958-T1	NTIS, PC A04/MF A01; 1	DE84003134	MN -95d	9:4543
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DOE/R6/10962-T1	NTIS, PC A02/MF A01; 1	DE84003545	MN -60	9:4560
DOE/R6/10965-T1	NTIS, PC A03/MF A01	DE84003505	MN -95d	9:4865
DOE/R6/10974-T1	NTIS, PC A02/MF A01; 1	DE84003450	MN -66	9:4557
DOE/R6/10981-T1	NTIS, PC A03/MF A01	DE84003503	MN -61a	9:4508
DOE/R6/10985-T1	NTIS, PC A02/MF A01	DE84003504	MN -61a	9:4911
DOE/R6/10986-T1	NTIS, PC A04/MF A01; 1	DE84003539	MN -95d	9:4558
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DOE/R6/12006-T1	NTIS, PC A03/MF A01	DE84003230	MN -95	9:4894
DOE/R6/12009-T1	NTIS, PC A03/MF A01; 1	DE84003536	MN -61a	9:4527
DOE/R6/12010-T1	NTIS, PC A02/MF A01	DE84003234	MN -95d	9:4868
DOE/R6/12012-T1	NTIS, PC A02/MF A01	DE84003429	MN -95	9:4895
DOE/R6/12014-T1	NTIS, PC A02/MF A01; 1	DE84003433	MN -95d	9:4869
T2	NTIS, PC A02/MF A01	DE84003430	MN -95d	9:4870
DOE/R6/12017-T1	NTIS, PC A02/MF A01; 1	DE84003159	MN -66	9:4553
DOE/R6/12019-T1	NTIS, PC A02/MF A01; 1	DE84003228	MN -61a	9:4509
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DOE/R6/12039-				
T1	NTIS, PC A02/MF A01	DE84003425	MN -66g	9:4873
DOE/R6/12041-				
T1	NTIS, PC A02/MF A01; 1	DE84003507	MN -96	9:4927
DOE/R6/12043-				
T1	NTIS, PC A05/MF A01; 1	DE84002999	MN -61a	9:4521
DOE/R6/12048-				
T1	NTIS, PC A02/MF A01; 1	DE84003158	MN -95d	9:4874
DOE/R6/12049-				
T1	NTIS, PC A04/MF A01; 1	DE84003157	MN -60	9:4563
DOE/R6/12053-				
T1	NTIS, PC A02/MF A01	DE84003426	MN -96	9:4929
DOE/R6/12055-				
T1	NTIS, PC A04/MF A01	DE84003145	MN -95e	9:4896
DOE/R6/12057-				
T1	NTIS, PC A04/MF A01; 1	DE84003137	MN -95d	9:4875
DOE/R6/12058-				
T1	NTIS, PC A09/MF A01; 1	DE84002428	MN -95d	9:4876
DOE/R6/12060-				
T1	NTIS, PC A02/MF A01	DE84003142	MN -60	9:4564
DOE/R6/12062-				
T1	NTIS, PC A02/MF A01; 1	DE84003155	MN -95d	9:4877
DOE/R6/12076-				
T1	NTIS, PC A02/MF A01; 1	DE84000955	MN -60	9:4565
DOE/R6/12078-				
T1	NTIS, PC A02/MF A01	DE84001207	MN -95f	9:4897
DOE/R6/12080-				
T1	NTIS, PC A06/MF A01; 1	DE83017947	MN -95	9:4913
DOE/R6/12083-				
T1	NTIS, PC A02/MF A01	DE84003535	MN -61a	9:4510
DOE/R6/12085-				
T1	NTIS, PC A02/MF A01	DE83017946	MN -61a	9:4511
DOE/RA/50574-				
T1	Van Nostrand Reinhold Co., 135 W. 50th St., New York, NY 10020		BK -92	9:4359
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T1	NTIS, PC A02/MF A01; 1	DE84002153	MN -97	9:4843
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0025-Vol.1	NTIS, PC A06/MF A01	DE84002179	MN -13	9:4795
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DOE/SF/01112-				
T3	NTIS, PC A02/MF A01	DE83016546	MN -79	9:4708
DOE/SF/02034-				
T83	NTIS MF A01; 2	DE84000877	MN -77	9:4631
DOE/SF/70046-				
T1	NTIS, PC A05/MF A01; 1	DE84002160	MN -77	9:4632
T2	NTIS, PC A07/MF A01; 1	DE84002156	MN -77	9:4633
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T5	NTIS, PC A07/MF A01; 1	DE84002163	MN -77	9:4636
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1-Rev.O	NTIS, PC A02/MF A01	DE84002329	MN -80	9:4610
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0011	NTIS, PC A02/MF A01; 1	DE84002238	MN -70	9:4445
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T10	NTIS, PC A02/MF A01	DE84003030	MN -11	9:5087
DOE/TIC-				
3400	NTIS, PC A22/MF A01	DE83017757	STD -11	9:4291
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4002304	NTIS, PC A02/MF A01	DE84002304	MN -4	9:5152
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1672	NTIS, PC A03/MF A01; 1	DE84003662	STD -11	9:5371
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83-72	NTIS, PC A02/MF A01	DE84003031	MN -70	9:4446
83-114	NTIS, PC A02/MF A01	DE84002620	MN -70	9:4447
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70-1457	NTIS MF A01; 2	DE84003029	MN -80	9:4709
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79-531	NTIS, PC A02/MF A01; 1	DE84002952	MN -80	9:4696
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83-635	NTIS, PC A02/MF A01	DE84002949	MN -80	9:4697
83-640	NTIS, PC A02/MF A01	DE84003026	MN -80	9:4698
83-643	NTIS, PC A03/MF A01	DE84002951	MN -80	9:4699
83-667	NTIS, PC A02/MF A01	DE84002950	MN -80	9:4700
83-714	NTIS, PC A02/MF A01	DE84003028	MN -80	9:4701
83-717(Del.)	NTIS, PC A03/MF A01; 1	DE84002820	MN -80	9:4711
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83-10330	*See* N-8326153			9:5437
83-10335	*See* N-8326155			9:4898
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1	NTIS (US Sales Only), PC A04/MF A01	DE84900195	MN -78	9:4628
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3	NTIS (US Sales Only), PC A03/MF A01	DE84900255	MN -78	9:4590
4	NTIS (US Sales Only), PC A04/MF A01	DE84900204	MN -78	9:4629
5	NTIS (US Sales Only), PC A03/MF A01	DE84900025	MN -78	9:4613
7	NTIS (US Sales Only), PC A03/MF A01	DE84900023	MN -78	9:4591
ECE/COAL-				
74	United Nations, New York, NY			9:4354
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131	NTIS (US Sales Only), PC A03/MF A01	DE83703861	MN -4	9:5055
132	NTIS (US Sales Only), PC A04/MF A01	DE83703846	MN -20	9:5589
EGG-M-				
05583	NTIS, PC A02/MF A01	DE84002157	MN -78	9:4712
08383	NTIS, PC A02/MF A01	DE84000885	MN -78	9:4713
12883	NTIS, PC A02/MF A01	DE84000803	MN -78	9:4714
13883	NTIS, PC A02/MF A01; 1	DE84002223	MN -80	9:4715
14283	NTIS, PC A02/MF A01	DE84002222	MN -78	9:4716
14583	NTIS, PC A02/MF A01; 1	DE84000897	MN -78	9:4717
15283	NTIS, PC A04/MF A01	DE84002894	MN -4	9:5056
15483	NTIS, PC A02/MF A01	DE84002225	MN -80	9:4657
16183	NTIS, PC A02/MF A01	DE84000801	MN -78	9:4718
16282	NTIS, PC A02/MF A01; 1	DE84001002	MN -80	9:4719
16583	NTIS, PC A02/MF A01	DE84000889	MN -78	9:4720
20083	NTIS, PC A02/MF A01; 1	DE84002205	MN -78	9:4721
20583	NTIS, PC A02/MF A01	DE84002217	MN -78	9:4722
20683	NTIS, PC A02/MF A01	DE84002216	MN -80	9:4723
20783	NTIS, PC A02/MF A01; 1	DE84002214	MN -78	9:4724
20883	NTIS, PC A02/MF A01	DE84002164	MN -78	9:4725
21283	NTIS, PC A02/MF A01	DE84002209	MN -78	9:4726
21483	NTIS, PC A02/MF A01; 1	DE84002113	MN -78	9:4727
21583	NTIS, PC A02/MF A01	DE84002208	MN -78	9:4728
21983	NTIS, PC A02/MF A01	DE84002203	MN -80	9:4658
22083	NTIS, PC A02/MF A01	DE84002632	MN -80	9:4659
22183	NTIS, PC A02/MF A01; 1	DE84002204	MN -78	9:4729
22283	NTIS, PC A02/MF A01; 1	DE84002211	MN -78	9:4730
22583	NTIS, PC A02/MF A01	DE84002207	MN -78	9:4731
EGG-PHYS-				
5735	NTIS, PC A04/MF A01	DE84002919	MN -37	9:5345
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EPRI-NP-				
2375	*See* NUREG/CR-2573	DE84900087	MN -78	9:4748
2376	*See* NUREG/CR-2574	DE84900137	MN -78	9:4749
3093	*See* NUREG/CR-3223	DE84900086	MN -78	9:4752
ESG-DOE-				
13406	NTIS, PC A07/MF A01	DE84003010	STD -91	9:4408
EUR-				
6299-EN-FR-Vol.2	Graham and Trotman Limited, Bond St. House, 14 Clifford St., London, England W1X 1RD			9:4375
8219-EN	European Community Information Service, 2100 M Street, NW, Suite 707, Washington, DC 20037		ND -59a	9:4545
EUR-CEA-FC-RA-				
1981	NTIS (US Sales Only), PC A04/MF A01	DE83703847	MN -20	9:5590
FE-				
2777-31	*See* DOE/ET/13005-T12	DE84003530	MN -90c	9:4281
2893-116	*See* DOE/ET/10069-T44	DE84002941	MN -90d	9:4280
GA-A-				
16538	NTIS, PC A99/MF A01; 1	DE84001643	STD -77	9:4638
17185	NTIS, PC A10/MF A01	DE84001614	STD -77	9:4595
GAO/EMD-				
82-88S	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -22	9:4421
GAO/GGD-				
83-39	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -13	9:4781
GAO/ID-				
83-31	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -98C	9:4401
GAO/NSIAD-				
83-08	General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20760		MN -98A	9:4387
GAO/PLRD-				
83-46	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -95d	9:4878
GAO/RCED-				
83-3	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -98C	9:4396
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83-161	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -11	9:4790
83-170	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -98E	9:4844
83-196	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -22	9:4782
83-203	US General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -98B	9:4357
83-210	General Accounting Office, Document Handling and Information Service Facility, P.O. Box 6015, Gaithersburg, MD 20760		MN -89	9:4355
GEAP-				
22051	*See* NUREG/CR-2573	DE84900087	MN -78	9:4748
22052	*See* NUREG/CR-2574	DE84900137	MN -78	9:4749
30157	*See* NUREG/CR-3223	DE84900086	MN -78	9:4752
GEPP-TIS-				
739	NTIS, PC A03/MF A01; 1	DE84003852	MN -13	9:5146
754b	NTIS, PC A03/MF A01; 1	DE84002959	MN -13	9:5650
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9775	NTIS (US Sales Only), PC A08/MF A01	DE84780036	MN -20c	9:5591
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2049	NTIS, PC A02/MF A01	DE84003467	STD -20g	9:5558
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2366	NTIS (US Sales Only), PC A07/MF A01	DE83703864	MN -4	9:5077
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82-081	NTIS (US Sales Only), PC A02/MF A01	DE83703858	MN -34D	9:5481
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SV El Salvador
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SZ Swaziland

TC Trucial Oman
TD Chad
TG Togo
TH Thailand
TN Tunisia
TO Tonga
TR Turkey
TT Trinidad and Tobago
TW Taiwan
TZ United Republic of Tanzania

UA Ukrainian Soviet Socialist Republic (Ukrainian SSR)
UG Uganda
US United States of America (USA)
UY Uruguay

VA Holy See
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VE Venezuela
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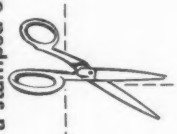

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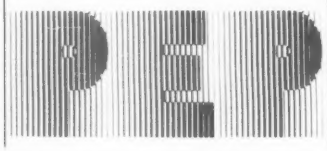

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